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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF CALIFORNIA
FRESNO DIVISION

THE STATE OF CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL, et al. Plaintiffs, v. COAST WOOD PRESERVING, INC., et al., Defendants.	No. CV-F-96-6055 AWI LJO CONSENT DECREE

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I. BACKGROUND

A. In September 1989, the U.S. Environmental Protection Agency ("EPA") placed the Site, described herein in Section IV, below, on the National Priorities List ("NPL"). Also in 1989 the California Department of Toxic Substances Control ("DTSC") became the lead Agency for the Site and continues to be the lead agency.

B. In December 1994, EPA and defendant Coast Wood Preserving, Inc., and other respondents entered into an Administrative Order on Consent, CERCLA Docket No. 95-06 ("1994 AOC") that, *inter alia,* required Coast Wood Preserving, Inc., to establish and to fund a $500,000 trust fund to pay for estimated future costs of Site clean-up (the "Trust Fund"). The parties to the 1994 AOC contemplated that DTSC, as lead agency, would be the primary beneficiary of the Trust Fund, and EPA the second beneficiary.

C. In 1996, DTSC and other plaintiffs (not including the United States), filed a complaint ("Complaint") in this litigation against Defendant Coast Wood Preserving, Inc. ("Performing Settling Defendant" or "Coast Wood Preserving, Inc."); Joyce Logsdon; and Harold Logsdon pursuant to, among other provisions of law, Section 107 of the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. § 9607. [Docket No. 1.] DTSC in its Complaint sought, *inter alia*, reimbursement of response costs it incurred in connection with response actions at the Site.

D. On August 16, 2006, the Court entered a consent decree between DTSC and the Performing Settling Defendant in this litigation [Docket No. 64] (the "2006

Consent Decree"), that, among other provisions, required the Performing Settling Defendant to (i) maintain the Trust Fund for the future remediation of the Site, (ii) to review every three years the needed future remedial actions and (iii) to prepare a tri-annual cost estimate of the needed remedial work beginning in August 2006 (the "Remedial Cost Estimate"). The 2006 Consent Decree also required that, in the event that the Site had not been fully remediated by July 31, 2016, that the Performing Settling Defendant agreed to "enter into a new Custodian Fund Agreement with substantially identical requirements on or before the date (July 31, 2016) the existing Trust Fund is terminated." (2006 Consent Decree, Paragraph 51.) The Custodian Fund Agreement was extended to and including January 31, 2017, by way of a First Amendment to the Custodian Fund Agreement. The Custodian Fund Agreement was extended to and including June 30, 2017 by way of the Second Amendment to the Custodian Fund Agreement, extended to and including December 31, 2017 by way of the Third Amendment to the Custodian Fund Agreement, and again extended to and including July 31, 2018 by way of the Fourth Amendment to the Custodian Fund Agreement, which is attached as Appendix A. The Fourth Amendment to the Custodian Fund Agreement will be superseded by this Consent Decree on the Effective Date, as defined herein. The United States was not a party to the 2006 Consent Decree, the Custodian Fund Agreement, or the First or Second Amendment to the Custodian Fund Agreement.

E. Paragraph 63 of the 2006 Consent Decree additionally stated, among other things, that it may be modified upon written approval of the parties to the 2006 Consent Decree and the Court, and, in Paragraph 66, that the parties' order for dismissal of this

action shall expressly indicate the court's retention of jurisdiction to enforce the terms of the 2006 Consent Decree.

F. DTSC has billed Performing Settling Defendant for response costs incurred by DTSC at or in connection with the Site, and the Performing Settling Defendant has timely paid DTSC for its response costs billed through June 30, 2017.

G. EPA has billed Performing Settling Defendant for response costs incurred by the United States at or in connection with the Site, and the Performing Settling Defendant has timely paid EPA for its response costs due, consistent with the terms of the 1994 AOC, billed through April 30, 2016.

H. Performing Settling Defendant does not admit any liability to Plaintiffs, as defined herein, arising out of the transactions or occurrences alleged in the Complaint, nor does it acknowledge that the release or threatened release of hazardous substance(s) at or from the Site constitutes an imminent and substantial endangerment to the public health or welfare or the environment.

I. Certain individuals and personal estates and trusts associated with the Site through past involvement with Coast Wood Preserving, Inc., including without limitation as shareholders, project coordinators, owners, operators and/or employees (collectively "Settling Individuals"), are also signatories to this revised Consent Decree. Joyce Logsdon, who is among the Settling Individuals, has previously been found liable under Section 107(a) of CERCLA in this litigation. The opportunity to participate in this revised Consent Decree and to receive the full benefit of Section XXII (Covenants by

Plaintiffs for Settling Individuals) provided incentive for Settling Individuals to transfer 100% of the shares of the corporate stock of Coast Wood Preserving, Inc. to new owners, under whose ownership Coast Wood Preserving, Inc. is willing and able to enter into this Consent Decree and assume obligations set forth herein, including completion of the remaining Work necessary at the Site (Section VI (Performance of the Work by Performing Settling Defendant)) and provision of necessary financial assurances for that Work (Section XIII (Performance Guarantee)).

J. Settling Individuals that have entered into this Consent Decree do not admit any liability to Plaintiffs arising out of the transactions or occurrences alleged in the Complaint, nor do they acknowledge that the release or threatened release of hazardous substance(s) at or from the Site constitutes an imminent and substantial endangerment to the public health or welfare or the environment.

K. The FOURTH FIVE-YEAR REVIEW for the Site, completed in September 2011 (approved by DTSC on September 22, 2011, and approved by EPA on September 28, 2011), set forth the course of the past remediation of the Site as follows:

1. "In 1972, the California Department of Fish and Game notified the Regional Water Quality Control Board (RWQCB) that chromated copper arsenate (CCA) wood preservation solution was being discharged via surface water runoff into tributaries of the Russian River. CWP [Coast Wood Preserving, Inc.] installed a slurry wall to contain the chromium-impacted groundwater and began groundwater extraction and treatment. The United States Environmental Protection Agency (EPA) listed the CWP [Site] on the National Priorities List (NPL) in September [1983]. The Department of

Toxic Substances Control (DTSC) has been the lead Agency overseeing the site investigation and cleanup."

2. "The remedy for soil and groundwater contamination selected in the September 1989 Remedial Action Plan (RAP) and 1989 Record of Decision (ROD) included paving the Site with an asphalt or concrete cap to prevent run-off and leaching of wood treatment solutions to the subsurface; installation of a downgradient slurry wall; groundwater extraction, treatment and reinjection; and soil excavation and off-site disposal after plant closure. Institutional controls were also implemented at the Site through a Land Use Covenant between DTSC and CWP, which imposes a limitation on the Site for non-residential use only."

3. "In July 1999, DTSC approved an amendment to the 1989 RAP which changed the remedial action for groundwater from extraction and treatment to *in situ* reduction and fixation of hexavalent chromium via direct injection and infiltration of calcium polysulfide reductant. The RAP Amendment also included a provision for using the *in situ* reduction and fixation for treating hexavalent chromium in soil. EPA concurred with the 1999 RAP Amendment in a letter dated August 25, 1999. Since the initiation of reductant injection and infiltration, chromium concentrations have decreased dramatically as compared to the former groundwater extraction remedy. Groundwater extraction controlled the spread of contamination, but was limited in its effectiveness in reducing chromium concentrations due to the low permeability of the Site subsurface soil and seasonal fluctuations of groundwater levels. Since 1990, no groundwater

contamination above the arsenic or chromium Maximum Contaminant Level (MCL) has been detected beyond the CWP property boundary."

4. "In August 2003, DTSC prepared and EPA concurred with an Explanation of Significant Differences (ESD). The ESD revised the cleanup goals for hexavalent chromium and arsenic in soil to 42 milligrams per kilogram (mg/kg) and 27 mg/kg, respectively. The ESD also modified the timing and the scope of the soil remediation. The RAP anticipated that soil cleanup would not be undertaken until the cessation of wood-preservation activities at the Site. In 2003, CWP proposed that some accessible contaminated soil could be remediated during plant operation due to upgrades that were being made. The ESD documented the modification of the scope and timing of soil cleanup."

L. A work plan was developed and approved by DTSC on December 13, 2002, for soil sampling within the accessible area south of the wood treatment area on the Site. This soil sampling results identified the areas contaminated with arsenic and hexavalent chromium above the soil cleanup goals. From September 2003 to February 2004, approximately 2,966 tons of accessible, impacted soil and surface cover material were removed in three excavation phases south of the wood treatment area on the Site and hauled to a permitted landfill for disposal. The soil removal was documented in the report titled "Final Summary of Removal and Replacement of Accessible Contaminated Soil at the Coast Wood Preserving Facility Ukiah, California," dated April 14, 2004 (revised June 14, 2004) (MWH, 2004b) (the "Final

Accessible Soil Summary Report"). DTSC approved the Final Accessible Soil Summary Report in writing on June 18, 2004.

M. In 2005, Coast Wood Preserving, Inc., conducted additional removal of approximately 2,734 tons of accessible soil beneath the former northern storm water tank farm and former 330,000-gallon water tank after these tanks had been removed. The soil removal was documented in the report titled "Final Summary of Characterization and Removal of Soil Beneath the Former Northern Storm Water Tank Farm and the 330,000-Gallon Water Tank (Report) for the Coast Wood Preserving Facility Ukiah, California," dated January 13, 2006 (revised September 22, 2006) (the "Final Tank Removal Soil Summary Report"). DTSC approved the Final Tank Removal Soil Summary Report in writing on November 8, 2006.

N. In 2006, Coast Wood Preserving, Inc., conducted additional removal of accessible soil beneath the new and former mix tank farm and associated utility trench after these tanks and surface fixtures had been removed. The soil removal was documented in the report titled "Final Summary of Characterization and Removal of Soil Beneath the New and Former Mix Tank Farm and Associated Utility Trench at the Coast Wood Preserving Facility Ukiah, California," dated December 19, 2006 (revised February 26, 2007) (the "Final Mix Tank Removal Soil Summary Report"). DTSC approved the Final Mix Tank Removal Soil Summary Report in writing on April 6, 2007.

O. The current Remedial Cost Estimate, dated April 29, 2016, generally covers the costs of removing currently inaccessible soil beneath current wood

treatment operation areas and ongoing groundwater treatment and monitoring. It was reviewed and approved by DTSC on June 29, 2016.

P. The Fifth Five-Year Review "recommends assessing the current remedy considering the site-specific risk for hexavalent chromium and consider whether it is appropriate to modify the remedy to include the new MCL [for hexavalent chromium]." The referenced "new MCL" of 10 µg/L is no longer applicable, due to the May 5, 2017 ruling in *California Manufacturer's & Technology Ass'n., et al. v. State Water Resources Control Board*, Sacramento County Superior Court Case No. 34-2014-80001850. Nevertheless, DTSC, after consultation with EPA, currently believes that (1) the current remedy would be fully protective of human health and the environment in both the short and long term if the Performance Standards were modified to cleanup levels of 10 µg/L for hexavalent chromium and (ii) changes to the remedy design and remedy implementation will not be needed to achieve groundwater cleanup levels of 10 µg/L for hexavalent chromium because, as stated in the Fifth Five-Year Review, "The remedy at the Coast Wood Preserving Superfund Site currently protects human health and the environment because the remedy is functioning as intended and no exposure pathways to contaminated media exist." (Fifth Five-Year Review at page ii.) Additionally, the Land Use Covenant recorded with respect to the Site (attached as Appendix B) limits the land uses at the Site to commercial and industrial uses and restricts the extraction of groundwater at the Site, which the Parties currently believe

will provide long term protection from contaminated soil and groundwater at the Site.

Q. Based on the information presently available to EPA and DTSC, EPA and DTSC believe that the Work will be properly and promptly conducted by Performing Settling Defendant if conducted in accordance with the requirements of this Consent Decree and its appendices.

R. Solely for the purposes of Section 113(j) of CERCLA, 42 U.S.C. § 9613(j), the remedy set forth in the Remedial Cost Estimate and the Work to be performed by Performing Settling Defendant shall constitute a "response action taken or ordered by the President for which judicial review shall be limited to the administrative record."

S. The Parties recognize, and the Court by entering this Consent Decree finds, that this Consent Decree has been negotiated by the Parties in good faith and that implementation of this Consent Decree will expedite the cleanup of the Site and will avoid prolonged and complicated litigation between the Parties, and that this Consent Decree is fair, reasonable, and in the public interest.

NOW, THEREFORE, it is hereby Ordered, Adjudged, and Decreed:

II. JURISDICTION

1. This Court has jurisdiction over the subject matter of this action pursuant to 28 U.S.C. §§ 1331 and 1345, and 42 U.S.C. §§ 9606, 9607, and 9613(b). This Court also has personal jurisdiction over Performing Settling Defendant and Settling

Individuals. Solely for the purposes of this Consent Decree and the underlying Complaint, Performing Settling Defendant and Settling Individuals waive all objections and defenses that they may have to jurisdiction of the Court or to venue in this District. Performing Settling Defendant and Settling Individuals shall not challenge the terms of this Consent Decree or this Court's jurisdiction to enter and enforce this Consent Decree.

III. PARTIES BOUND

2. This Consent Decree applies to and is binding upon the Plaintiffs and upon Performing Settling Defendant and its successors and assigns. Any change in ownership or corporate status of Performing Settling Defendant including, but not limited to, any transfer of assets or real or personal property, shall in no way alter Performing Settling Defendant's responsibilities under this Consent Decree. This Consent Decree also applies to and is binding upon the Settling Individuals to the extent provided in Section III.4.

3. Performing Settling Defendant shall provide a copy of this Consent Decree to each contractor hired to perform the Work required by this Consent Decree and to each person representing Performing Settling Defendant with respect to the Site or the Work, and shall condition all contracts entered into hereunder upon performance of the Work in conformity with the terms of this Consent Decree. Performing Settling Defendant or its contractors shall provide written notice of the Consent Decree to all subcontractors hired to perform any portion of the Work required by this Consent Decree. Performing Settling Defendant shall nonetheless be responsible for ensuring that its contractors and subcontractors perform the Work in accordance with the terms of this

Consent Decree. With regard to the activities undertaken pursuant to this Consent Decree, each contractor and subcontractor shall be deemed to be in a contractual relationship with Performing Settling Defendant within the meaning of Section 107(b)(3) of CERCLA, 42 U.S.C. § 9607(b)(3).

4. Certain Sections and Paragraphs of this Consent Decree address the specific obligations and covenants applicable to Settling Individuals, and accordingly only the following Sections and Paragraphs apply to and are binding upon Settling Individuals: (a) Section I (Background); (b) Section II (Jurisdiction); (c) Section IV (Definitions); (d) Section XXII (Covenants by Plaintiffs for Settling Individuals); (e) Section XXIII (Covenants by Performing Settling Defendant and Settling Individuals for Plaintiffs); (f) Section XXIV (Effect of Settlement; Contribution); (g) Paragraph 114 (Surrender of Site-related Records by Settling Individuals); (h) Section XXVIII (Retention of Jurisdiction); (i) Section XXXI (Modification); (j) Section XXXII (Lodging and Opportunity for Public Comment); and (k) Section XXXIII (Signatories/Service).

IV. DEFINITIONS

5. Unless otherwise expressly provided in this Consent Decree, terms used in this Consent Decree that are defined in CERCLA or in regulations promulgated under CERCLA shall have the meaning assigned to them in CERCLA or in such regulations. Whenever terms listed below are used in this Consent Decree or its appendices, the following definitions shall apply solely for purposes of this Consent Decree:

"1994 AOC" shall mean the December 4, 1994 Administrative Order on Consent, CERCLA Docket No. 95-06, between EPA and Performing Settling Defendant and other respondents. The 1994 AOC is attached as Appendix C.

"2003 ESD" shall mean the Explanation of Significant Differences prepared by DTSC, and concurred to by EPA, in August 2003.

"2006 Consent Decree" shall mean the prior consent decree entered by this Court on August 16, 2006 [Docket No. 64].

"CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601-9675.

"Coast Wood Preserving Special Account (SSID 0945)" shall mean the special account, within the EPA Hazardous Substance Superfund, established for the Site by EPA pursuant to Section 122(b)(3) of CERCLA, 42 U.S.C. § 9622(b)(3).

"Consent Decree" shall mean this Consent Decree and all appendices attached hereto (listed in Section XXIX). In the event of conflict between this Consent Decree and any appendix, this Consent Decree shall control.

"Day" or "day" shall mean a calendar day unless expressly stated to be a working day. The term "working day" shall mean a day other than a Saturday, Sunday, or federal or state holiday. In computing any period of time under this Consent Decree, where the last day would fall on a Saturday, Sunday, or federal or state holiday, the period shall run until the close of business of the next working day.

"DOJ" shall mean the United States Department of Justice and its successor departments, agencies, or instrumentalities.

"DTSC" shall mean the State of California Department of Toxic Substances Control and any successor departments or agencies of the State of California.

"DTSC Future Response Costs" shall mean all costs, including, but not limited to, direct and indirect costs, that DTSC incurs, after the Effective Date, in reviewing or developing plans, reports, and other deliverables submitted pursuant to this Consent Decree, in overseeing implementation of the Work, or otherwise implementing, overseeing, or enforcing this Consent Decree, including, but not limited to, payroll costs, contractor costs, travel costs, laboratory costs, the costs incurred pursuant to Paragraph 9 (Permits), Paragraph 10 (Notice to Successors-in-Title and Transfers of Real Property), Section VII (Remedy Review), Section IX (Access and Institutional Controls) (including, but not limited to, the cost of attorney time and any monies paid to secure access and/or to secure, implement, monitor, maintain, or enforce Institutional Controls including, but not limited to, the amount of just compensation), Section XV (Emergency Response), Paragraph 48 (Funding for Work Takeover), and Section XXX (Community Involvement). DTSC Future Response Costs shall also include all DTSC Interim Response Costs.

"DTSC Interest" shall mean interest at the rate specified in California Health and Safety Code § 25360.1.

"DTSC Interim Response Costs" shall mean all costs, including, but not limited to, direct and indirect costs, (a) paid by DTSC in connection with the Site between July 1, 2017, and the Effective Date, or (b) incurred by DTSC in connection with the Site prior to the Effective Date but paid by DTSC after that date.

"Effective Date" shall mean the later of: (1) the date upon which this Consent Decree is entered by the Court as recorded on the Court docket, or, if the Court instead issues an order approving the Consent Decree, the date such order is recorded on the Court docket; or (2) the date upon which a consent decree resolving the claims of the United States and DTSC in the related case United States v. Valley Wood Preserving, Inc., et. al., Civil Action No. 94-5984, is entered by the Court as recorded on the Court docket, or if the Court instead issues an order approving the consent decree, the date such order is recorded in the Court docket.

"EPA" shall mean the United States Environmental Protection Agency and its successor departments, agencies, or instrumentalities.

"EPA Hazardous Substance Superfund" shall mean the Hazardous Substance Superfund established by the Internal Revenue Code, 26 U.S.C. § 9507.

"Groundwater Monitoring Plan" shall mean the Monitoring and Reporting Program Order No. R1-2012-0055 for Coast Wood Preserving issued by the California Regional Water Quality Control Board, North Coast Region, dated April 3, 2012.

"Institutional Controls" or "ICs" shall mean Proprietary Controls and state or local laws, regulations, ordinances, zoning restrictions, or other governmental controls or

notices that: (a) limit land, water, and/or resource use to minimize the potential for human exposure to Waste Material at or in connection with the Site; (b) limit land, water, and/or resource use to implement, ensure non-interference with, or ensure the protectiveness of the Remedial Action; and/or (c) provide information intended to modify or guide human behavior at or in connection with the Site.

"Interest" for EPA shall mean interest at the rate specified for interest on investments of the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, compounded annually on October 1 of each year, in accordance with 42 U.S.C. § 9607(a). The applicable rate of interest shall be the rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year.

"National Contingency Plan" or "NCP" shall mean the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, codified at 40 C.F.R. Part 300, and any amendments thereto.

"Operation and Maintenance" or "O&M" shall mean all activities required to operate, maintain, and monitor the effectiveness of the Remedial Action as specified in the SOW, Remedial Cost Estimate, or any DTSC-approved O&M Plan.

"Paragraph" shall mean a portion of this Consent Decree identified by an Arabic numeral or an upper or lower case letter.

"Parties" shall mean the Plaintiffs, Performing Settling Defendant and Settling Individuals.

"Performance Standards" shall mean the cleanup standards and other measures of achievement of the goals of the Remedial Action, set forth in the general assumptions of the Remedial Cost Estimate and any modified standards established pursuant to this Consent Decree, which include specifically the soil and groundwater Performance Standards for total chromium, hexavalent chromium, and arsenic as listed in the table below and established pursuant to the ROD and ESD.

Soil Cleanup Goals		**Groundwater Cleanup Goals**	
Total Chromium	100 mg/kg[1]	Total Chromium	50 µg/L [3]
Hexavalent Chromium	42 mg/kg[2]	Hexavalent Chromium	50 µg/L[4]
Arsenic	27 mg/kg[2]	Arsenic	10 µg/L[5]
[1] Applicable or relevant and appropriate requirement (ARARs) as shown in the 2003 ESD page 4. [2]ARARs as shown in the 2003 ESD Page 3.		[3]ARARs as shown in the 1989 ROD (Section 6.3.1, p. 30, and Table 10, p. 56). [4] ARARs as shown in the 1989 ROD (Table 10, p. 56) [5] The California MCL for arsenic is 10 µg/L as of November 28, 2008. µg/L = micrograms per liter.	

"Performing Settling Defendant" shall mean Coast Wood Preserving, Inc.

"Plaintiffs" shall mean the United States, DTSC, and the California Toxic Substances Control Account.

"Proprietary Controls" shall mean easements or covenants running with the land that (a) limit land, water, or resource use and/or provide access rights and (b) are created pursuant to common law or statutory law by an instrument that is recorded by the owner in the appropriate land records office.

"RCRA" shall mean the Solid Waste Disposal Act, 42 U.S.C. §§ 6901-6992 (also known as the Resource Conservation and Recovery Act).

"Record of Decision" or "ROD" shall mean the EPA Record of Decision relating to the Site signed on September 29, 1989, by the Regional Administrator, EPA Region IX, or his/her delegate, and all attachments thereto. The ROD is attached as Appendix D.

"Remedial Action" shall mean all activities Performing Settling Defendant is required to perform under the Consent Decree to implement the ROD and RAP, in accordance with the SOW, Remedial Cost Estimate and other plans approved by DTSC, including implementation of Institutional Controls, until the Performance Standards are met, and excluding performance of O&M and the activities required under Section XXVI (Retention of Records).

"Remedial Action Plan" or "RAP" shall mean the 1989 RAP as amended by the 1999 RAP Amendment and later revised by the 2003 ESD. The RAP including the RAP Amendment and ESD is attached at Appendix E.

"Remedial Cost Estimate" shall mean the Remedial Cost Estimate for Coast Wood Preserving dated April 29, 2016, and reviewed and approved by DTSC on June 29, 2016, including the "Revised Appendix A Third Revision April 2016." The current Remedial Cost Estimate is attached as Appendix F. The next Remedial Cost Estimate must be submitted for review and approval by DTSC by April 1, 2021, and shall be submitted every five years thereafter until such time that the Five-Year Review requirement under the NCP no longer requires such Five-Year Reviews.

"Section" shall mean a portion of this Consent Decree identified by a Roman numeral.

"Settling Individuals" shall mean the Michael Logsdon Wood Trust, the Schmidt Wood Trust, Joyce Logsdon and Eugene E. Pietila, all of whom hold, or have previously held, shares in Coast Wood Preserving, Inc., and Robert Schmidt, who was formerly the designated Project Coordinator for the Coast Wood Preserving, Inc. Site.

"Site" shall mean the Coast Wood Preserving, Inc. facility located at the southwest corner of Taylor Drive and Plant Roads on the southern side of the City of Ukiah, Mendocino County, California, which includes approximately 8 acres and is generally identified as Mendocino County Assessor Parcel Numbers 184-140-08 and 184-110-11. The Site includes all areas, including those areas outside the described parcels, where hazardous substances disposed of at the Coast Wood Preserving, Inc. facility or released from the Coast Wood Preserving, Inc. facility have come to be located. The Site is depicted generally on the map attached as Appendix G.

"State" shall mean the State of California.

"Statement of Work" or "SOW" shall mean the statement of work for implementation of the Remedial Design, Remedial Action, and O&M at the Site, as set forth in Appendix H to this Consent Decree and any modifications made in accordance with this Consent Decree.

"Supervising Contractor" shall mean the principal contractor retained by Performing Settling Defendant to supervise and direct the implementation of the Work under this Consent Decree.

"Toxic Substances Control Account" shall mean the account within the State of California General Fund, established by California Health and Safety Code § 25173.6. and administered by the director of DTSC, which, under California Health and Safety Code §25361(a), is a party in any action for recovery of response costs or expenditures incurred from the account under Chapter 6.8 of Division 20 of the California Health and Safety Code.

"Transfer" shall mean to sell, assign, convey, lease, mortgage, or grant a security interest in, or where used as a noun, a sale, assignment, conveyance, or other disposition of any interest by operation of law or otherwise.

"United States" shall mean the United States of America and each department, agency, and instrumentality of the United States, including EPA.

"United States Future Response Costs" shall mean all costs, including, but not limited to, direct and indirect costs, that the United States incurs in reviewing or developing plans, reports, and other deliverables submitted pursuant to this Consent Decree, in overseeing implementation of the Work, or otherwise implementing, overseeing, or enforcing this Consent Decree, including, but not limited to, payroll costs, contractor costs, travel costs, laboratory costs, the costs incurred pursuant to Paragraph 10 (Notice to Successors-in-Title and Transfers of Real Property), Section VII (Remedy Review), Section IX (Access and Institutional Controls) (including, but not limited to, the

cost of attorney time and any monies paid to secure access and/or to secure, implement, monitor, maintain, or enforce Institutional Controls including, but not limited to, the amount of just compensation), Section XV (Emergency Response), Paragraph 48 (Funding for Work Takeover), and Section XXX (Community Involvement). Future Response Costs shall also include all United States Interim Response Costs.

"United States Interim Response Costs" shall mean all costs, including, but not limited to, direct and indirect costs, (a) paid by the United States in connection with the Site between May 1, 2016, and the Effective Date, or (b) incurred prior to the Effective Date but paid after that date.

"United States Past Response Costs" shall mean fifty-seven thousand, four hundred and fifty and 38/100 dollars ($57,450.38) in unreimbursed costs, including, but not limited to, direct and indirect costs, that the United States paid at or in connection with the Site from and including March 1, 1994 through and including April 30, 2016.

"Waste Material" shall mean (1) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (2) any pollutant or contaminant under Section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (3) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C.§ 6903(27); and (4) any California Non-RCRA hazardous waste, pursuant to the California Code of Regulations (CCR) Title 22, Section 66261.

"Work" shall mean all activities and obligations Performing Settling Defendant is required to perform under this Consent Decree, except the activities required under Section XXVI (Retention of Records).

V. GENERAL PROVISIONS

6. Objectives of the Parties. The objectives of the Parties in entering into this Consent Decree are: (1) to protect public health or welfare or the environment by the design and implementation of response actions at the Site by Performing Settling Defendant; (2) to resolve the claims of Plaintiffs against Performing Settling Defendant as provided in this Consent Decree; and (3) to resolve the claims or potential claims of Plaintiffs against Settling Individuals in connection with the Site as provided in this Consent Decree.

7. Commitments by Performing Settling Defendant. Performing Settling Defendant shall finance and perform the Work in accordance with this Consent Decree, Remedial Cost Estimate, the SOW, and all work plans and other plans, standards, specifications, and schedules set forth in this Consent Decree or developed by Performing Settling Defendant and approved by DTSC or EPA pursuant to this Consent Decree. Performing Settling Defendant shall pay for DTSC Future Response Costs, United States Future Response Costs, and United States Past Response Costs as provided in this Consent Decree.

8. Compliance With Applicable Law. All activities undertaken by Performing Settling Defendant pursuant to this Consent Decree shall be performed in accordance with the requirements of all applicable federal, state and local laws and regulations. Performing Settling Defendant must also comply with all applicable or relevant and appropriate requirements of all federal and state environmental laws as set forth in Remedial Cost Estimate and the SOW and the Performance Standards defined in

the Consent Decree. The activities conducted pursuant to this Consent Decree, if approved by DTSC or EPA, shall be deemed to be consistent with the NCP.

9. Permits.

a. As provided in Section 121(e) of CERCLA, 42 U.S.C. § 9621(e), and Section 300.400(e) of the NCP, no permit shall be required for any portion of the Work conducted entirely on-Site (i.e., within the areal extent of contamination or in very close proximity to the contamination and necessary for implementation of the Work). Where any portion of the Work that is not on-Site requires a federal, state or local permit or approval, Performing Settling Defendant shall submit timely and complete applications and take all other actions necessary to obtain all such permits or approvals.

b. Performing Settling Defendant may seek relief under the provisions of Section XVIII (Force Majeure) for any delay in the performance of the Work resulting from a failure to obtain, or a delay in obtaining, any permit or approval referenced in Paragraph 9.a. and required for the Work, provided that it has submitted timely and complete applications and taken all other actions necessary to obtain all such permits or approvals.

c. This Consent Decree is not, and shall not be construed to be, a permit issued pursuant to any federal, state or local statute or regulation.

d. DTSC agrees that any DTSC permit relating to the Work shall be conformed to the requirements of this Consent Decree, and that to the extent such conformance does not occur (or for any period during which such conformance has not

occurred) and relates to Work that is on-Site, such permit shall be inapplicable to the Work pursuant to Section 121(e) of CERCLA, 42 U.S.C. § 9621(e).

10. Notice to Successors-in-Title and Transfers of Real Property.

a. Performing Settling Defendant shall, at least 60 days prior to any Transfer of any real property comprising part of the Site, give written notice: (1) to the transferee regarding the Consent Decree and any Institutional Controls regarding the real property; and (2) to DTSC and EPA regarding the proposed Transfer, including the name and address of the transferee and the date on which the transferee was notified of the Consent Decree and any Institutional Controls.

b. Performing Settling Defendant recorded the Institutional Control (Land Use Covenant) on November 29, 1989, with the County of Mendocino (Official Records of the Recorders Office: Book 1729, Page 564). (Appendix B.)

c. In the event of any Transfer of real property comprising part of the Site, unless DTSC otherwise consents in writing, after reasonable opportunity for review and comment by EPA, Performing Settling Defendant shall continue to comply with its obligations under the Consent Decree, including, but not limited to, its obligation to provide and/or secure access; to implement, maintain, monitor, and report on Institutional Controls; and to abide by such Institutional Controls.

11. Effect of this Consent Decree on 2006 Consent Decree and Administrative Order on Consent. The obligations, liabilities and duties of Performing Settling Defendant contained in this Consent Decree supersede and replace any obligations,

liabilities and duties of Performing Settling Defendant set forth in: (a) the 2006 Consent Decree that was entered by the Court on August 16, 2006 [Docket No. 64]; and (b) the 1994 AOC, with the sole exception set forth in Paragraph 54.a regarding payment of the United States Past Response Costs.

VI. PERFORMANCE OF THE WORK BY PERFORMING SETTLING DEFENDANT

12. Selection of Supervising Contractor.

a. All aspects of the Work to be performed by Performing Settling Defendant pursuant to Sections VI (Performance of the Work by Performing Settling Defendant), VIII (Quality Assurance, Sampling, and Data Analysis), IX (Access and Institutional Controls), and XV (Emergency Response) shall be under the direction and supervision of the Supervising Contractor. Performing Settling Defendant selected and, after reasonable opportunity for review and comment by EPA, DTSC approved hiring by Performing Settling Defendant of the following person as Supervising Contractor: Mark Underwood of EnvironAnalytics Group, LLC. If at any time hereafter, Performing Settling Defendant proposes to change this Supervising Contractor, Performing Settling Defendant shall give such notice to EPA and DTSC and must obtain an authorization to proceed from DTSC, after a reasonable opportunity for review and comment by EPA, before the new Supervising Contractor performs, directs, or supervises any Work under this Consent Decree. Performing Settling Defendant shall demonstrate that the proposed replacement contractor has a quality assurance system that complies with ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data

Collection and Environmental Technology Programs" (American National Standard, January 5, 1995), by submitting a copy of the proposed contractor's Quality Management Plan ("QMP"). The QMP should be prepared in accordance with "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01/002, March 2001, reissued May 2006) or equivalent documentation as determined by EPA.

b. If DTSC disapproves a replacement Supervising Contractor, DTSC will notify Performing Settling Defendant in writing. Performing Settling Defendant shall submit to DTSC and EPA a list of contractors, including the qualifications of each contractor, that would be acceptable to it within 30 days after receipt of DTSC's disapproval of the contractor previously proposed. DTSC will provide written notice of the names of any contractor(s) that it approves and an authorization to proceed with respect to those contractors. Performing Settling Defendant may select any contractor from that list and shall notify DTSC and EPA of the name of the contractor selected within twenty-one (21) days after DTSC's authorization to proceed.

c. If DTSC fails to provide written notice of its authorization to proceed or disapproval as provided in this Paragraph and this failure prevents Performing Settling Defendant from meeting one or more deadlines in a plan approved by DTSC pursuant to this Consent Decree, Performing Settling Defendant may seek relief under Section XVIII (Force Majeure).

13. <u>Remedial Design and Remedial Action</u>

a. Performing Settling Defendant shall conduct the following remedial action for the Site: removal of contaminated soil following the cessation of wood treatment business operations at the Site and an assessment and implementation of any necessary institutional and engineering controls, including paving soil remediation areas if necessary, and continued groundwater sampling and management until Performance Standards have been met in all Site wells.

b. Performing Settling Defendant has already submitted the Remedial Cost Estimate (Appendix F). DTSC has approved the Remediation Cost Estimate and it is incorporated into and is an enforceable part of this Consent Decree.

c. Performing Settling Defendant has already submitted a Site Health and Safety Plan for field activities required by the Remedial Cost Estimate that DTSC and EPA has reviewed and that conforms to the applicable Occupational Safety and Health Administration and EPA requirements including, but not limited to, 29 C.F.R. § 1910.120.

d. Performing Settling Defendant. shall conduct activities and submit deliverables to EPA and DTSC for completion of the removal of contaminated soil following the cessation of wood treatment business operations at the Site and continued groundwater sampling and management as set forth in this Consent Decree and the SOW.

e. Performing Settling Defendant shall continue to implement the Remedial Action until the Performance Standards are achieved. Performing Settling Defendant shall implement O&M for so long thereafter as is required by the Land Use

Covenant, Groundwater Monitoring Plan, Remedial Cost Estimate, the SOW, or any other portion of this Consent Decree and consistent with CERCLA Section 121(c), 42 U.S.C. § 9621(c).

14. Modification of SOW or Related Work Plans.

a. If DTSC determines that it is necessary to modify the work specified in the SOW and/or in work plans already submitted to and approved by DTSC or developed pursuant the SOW, in order to achieve and maintain the Performance Standards or to carry out and maintain the effectiveness of the remedy set forth in the Remedial Cost Estimate and this Consent Decree, and such modification is consistent with the scope of the remedy set forth in the Remedial Cost Estimate and this Consent Decree, then DTSC may, after a reasonable opportunity for review and comment by EPA, issue such modification in writing and shall notify Performing Settling Defendant of such modification. For the purposes of this Paragraph and Paragraphs 50 (Completion of the Remedial Action) and 51 (Completion of the Work) only, the scope of the remedy is: The removal of contaminated soil following the cessation of wood treatment business operations at the Site and an assessment and implementation of any necessary institutional and engineering controls, including paving soil remediation areas if necessary, and continued groundwater sampling and management until Performance Standards are met in all Site wells. If Performing Settling Defendant objects to the modification it may, within 30 days after DTSC's notification, seek dispute resolution under Paragraph 72 (Record Review) Section XIX.

b. The SOW and/or related work plans shall be modified (1) in accordance with the modification issued by DTSC, or (2) if Performing Settling Defendant invokes dispute resolution, in accordance with the final resolution of the dispute. The modification shall be incorporated into and enforceable under this Consent Decree, and Performing Settling Defendant shall implement all work required by such modification. Performing Settling Defendant shall incorporate the modification into the Remedial Cost Estimate under Paragraph 13 (Remedial Design and Remedial Action).

c. Nothing in this Paragraph shall be construed to limit DTSC's or EPA's authority to require performance of further response actions as otherwise provided in this Consent Decree.

15. Nothing in this Consent Decree, the SOW, or the Remedial Cost Estimate constitutes a warranty or representation of any kind by Plaintiffs that compliance with the work requirements set forth in the SOW and the work plans will achieve the Performance Standards.

16. Off-Site Shipment of Waste Material.

a. Performing Settling Defendant may ship Waste Material from the Site pursuant to this Consent Decree to an off-Site facility only if it verifies, prior to any shipment, that the off-Site facility is operating in compliance with the requirements of Section 121(d)(3) of CERCLA, 42 U.S.C. § 9621(d)(3), and 40 C.F.R. § 300.440, by obtaining a determination from EPA that the proposed receiving facility is operating in compliance with 42 U.S.C. § 9621(d)(3) and 40 C.F.R. § 300.440.

b. Performing Settling Defendant may ship Waste Material from the Site pursuant to this Consent Decree to an out-of-state waste management facility only if, prior to any shipment, it provides written notice to the appropriate state environmental official in the receiving facility's state and to the DTSC and EPA Project Managers. This notice requirement shall not apply to any off-Site shipments when the total quantity of all such shipments will not exceed ten cubic yards. The written notice shall include the following information, if available: (1) the name and location of the receiving facility; (2) the type and quantity of Waste Material to be shipped; (3) the schedule for the shipment; and (4) the method of transportation. Performing Settling Defendant shall also notify the state environmental official referenced above and the DTSC and EPA Project Managers of any major changes in the shipment plan, such as a decision to ship the Waste Material to a different out-of-state facility. Performing Settling Defendant shall provide the written notice after the award of the contract for Remedial Action construction and before the Waste Material is shipped.

VII. REMEDY REVIEW

17. Periodic Review. Performing Settling Defendant shall conduct any studies and investigations that DTSC or EPA requests in order to permit DTSC or EPA to conduct reviews of whether the Remedial Action is protective of human health and the environment at least every five years as required by Section 121(c) of CERCLA, 42 U.S.C. § 9621(c), and any applicable regulations.

18. Selection of Further Response Actions. If DTSC or EPA determines, at any time, that the Remedial Action is not protective of human health and the

environment, DTSC, with concurrence from EPA, may select further response actions for the Site in accordance with the requirements of CERCLA and the NCP, or DTSC may select further response actions for the Site in accordance with applicable state law.

19. Opportunity To Comment. Performing Settling Defendant and, if required by Sections 113(k)(2) or 117 of CERCLA, 42 U.S.C. § 9613(k)(2) or 9617, the public, will be provided with an opportunity to comment on any further response actions proposed by DTSC, with concurrence from EPA, as a result of the review conducted pursuant to Section 121(c) of CERCLA and to submit written comments for the record during the comment period.

20. Performing Settling Defendant's Obligation To Perform Further Response Actions. If DTSC, with concurrence from EPA, selects further response actions relating to the Site, DTSC, in consultation with EPA, may require Performing Settling Defendant to perform such further response actions, but only to the extent that the reopener conditions in Paragraph 90 or Paragraph 91 (DTSC's Pre- and Post-Certification Reservations) are satisfied. Performing Settling Defendant may invoke the appropriate procedures set forth in Section XIX (Dispute Resolution) to dispute (a) DTSC's determination that the reopener conditions of Paragraph 90 or Paragraph 91 are satisfied, (b) DTSC's or EPA's determination that the Remedial Action is not protective of human health and the environment, or (c) DTSC's selection of the further response actions. Disputes pertaining to whether the Remedial Action is protective or to selection of further response actions shall be resolved pursuant to Paragraph 72 (Record Review) for decisions made by DTSC and Paragraph 67 (Record Review) for decisions made by the

United States, respectively. For purposes of satisfying the reopener conditions in Paragraph 90 or 91 (DTSC's Pre- and Post-Certification Reservations), establishment of a new California MCL for hexavalent chromium will constitute "information, previously unknown" to DTSC and EPA.

21. Submission of Plans. If Performing Settling Defendant is required to perform further response actions pursuant to Paragraph 20, it shall submit a plan for such response action to DTSC and EPA, for approval by DTSC, in consultation with EPA, in accordance with the procedures of Section VI (Performance of the Work by Performing Settling Defendant). Performing Settling Defendant shall implement the approved plan in accordance with this Consent Decree.

VIII. QUALITY ASSURANCE, SAMPLING, AND DATA ANALYSIS

22. Quality Assurance.

a. Performing Settling Defendant shall use quality assurance, quality control, and chain of custody procedures that have been previously approved, as modified in the future as appropriate, for all samples in accordance with "EPA Requirements for Quality Assurance Project Plans (QA/R5)" (EPA/240/B-01/003, March 2001, reissued May 2006), "Guidance for Quality Assurance Project Plans (QA/G-5)" (EPA/240/R-02/009, December 2002), and subsequent amendments to such guidelines upon notification by DTSC to Performing Settling Defendant of such amendment. Amended guidelines shall apply only to procedures conducted after such notification.

b. The previously approved Quality Assurance Project Plan ("QAPP"), as modified in the future as appropriate, is incorporated into the SOW. If

relevant to the proceeding, Plaintiffs and Performing Settling Defendant agree that validated sampling data generated in accordance with the QAPP and reviewed and approved by DTSC shall be admissible as evidence, without objection, in any proceeding under this Consent Decree. Performing Settling Defendant shall ensure that EPA and DTSC personnel and their authorized representatives are allowed access at reasonable times to all laboratories utilized by Performing Settling Defendant in implementing this Consent Decree. In addition, Performing Settling Defendant shall ensure that such laboratories shall analyze all samples submitted by DTSC pursuant to the QAPP for quality assurance monitoring. Performing Settling Defendant shall ensure that the laboratories it utilizes for the analysis of samples taken pursuant to this Consent Decree perform all analyses according to accepted methods. Accepted methods consist of those methods that are documented in the "USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis, ILM05.4," and the "USEPA Contract Laboratory Program Statement of Work for Organic Analysis, SOM01.2," and any amendments made thereto during the course of the implementation of this Consent Decree; however, upon approval by DTSC, after opportunity for review and comment by EPA, Performing Settling Defendant may use other analytical methods that are as stringent as or more stringent than the CLP-approved methods. Performing Settling Defendant shall ensure that all laboratories it uses for analysis of samples taken pursuant to this Consent Decree participate in an EPA or EPA-equivalent quality assurance/quality control ("QA/QC") program. Performing Settling Defendant shall use only laboratories that have a documented Quality System that complies with ANSI/ASQC E4-1994, "Specifications

and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs" (American National Standard, January 5, 1995), and "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01/002, March 2001, reissued May 2006) or equivalent documentation as determined by DTSC. DTSC may consider laboratories accredited under the National Environmental Laboratory Accreditation Program ("NELAP") as meeting the Quality System requirements. Performing Settling Defendant shall ensure that all field methodologies utilized in collecting samples for subsequent analysis pursuant to this Consent Decree are conducted in accordance with the procedures set forth in the QAPP approved by DTSC.

23. Upon request, Performing Settling Defendant shall allow split or duplicate samples to be taken by DTSC and by EPA, or their authorized representatives. Performing Settling Defendant shall notify DTSC and EPA not less than 28 days in advance of any sample collection activity unless shorter notice is agreed to by DTSC. In addition, DTSC and EPA shall have the right to take any additional samples that DTSC and EPA deem necessary. Upon request, DTSC and EPA shall allow Performing Settling Defendant to take split or duplicate samples of any samples they take as part of Plaintiffs' oversight of Performing Settling Defendant's implementation of the Work.

24. Performing Settling Defendant shall submit to EPA and DTSC electronic copies of the results of all sampling and/or tests or other data obtained or generated by or on behalf of Performing Settling Defendant with respect to the Site and/or the implementation of this Consent Decree unless DTSC and EPA agree otherwise.

25. Notwithstanding any provision of this Consent Decree, DTSC, other California state agencies, and the United States retain all of their information gathering and inspection authorities and rights, including enforcement actions related thereto, under CERCLA, RCRA, and any other applicable statutes or regulations.

IX. ACCESS AND INSTITUTIONAL CONTROLS

26. If the Site, or any other real property where access or land/water use restrictions are needed, is owned or controlled by Performing Settling Defendant:

a. Performing Settling Defendant shall, commencing on the date of lodging of the Consent Decree, provide DTSC and the United States with access at all reasonable times to the Site, or such other real property, to conduct any activity regarding the Consent Decree including, but not limited to, the following activities:

(1) Monitoring the Work;

(2) Verifying any data or information submitted to the DTSC and the United States;

(3) Conducting investigations regarding contamination at or near the Site;

(4) Obtaining samples;

(5) Assessing the need for, planning, or implementing additional response actions at or near the Site;

(6) Assessing implementation of quality assurance and quality control practices as defined in the approved QAPP;

(7) Implementing the Work pursuant to the conditions set forth in Paragraph 94 (Work Takeover);

(8) Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Performing Settling Defendant or its agents, consistent with Section XXV (Access to Information);

(9) Assessing Performing Settling Defendant's compliance with the Consent Decree;

(10) Determining whether the Site or other real property is being used in a manner that is prohibited or restricted, or that may need to be prohibited or restricted under the Consent Decree; and

(11) Implementing, monitoring, maintaining, reporting on, and enforcing any Institutional Controls.

b. Commencing on the date of lodging of the Consent Decree, Performing Settling Defendant shall not use the Site, or such other real property, in any manner that DTSC determines will pose an unacceptable risk to human health or to the environment due to exposure to Waste Material or interfere with or adversely affect the implementation, integrity, or protectiveness of the Remedial Action or O&M.

27. As required by the 1989 DTSC approved RAP and the EPA approved Record of Decision, a Land Use Covenant between DTSC and the Performing Settling Defendant was recorded on November 29, 1989, with the County of Mendocino (Official Records of the Recorders Office: Book 1729, Page 564.) that restricts the use of the Site

to non-residential uses and requires the maintenance of an asphalt or concrete cap over the Site until such time as the soil remediation has begun in accordance with the approved RAP and Remedial Design. (Appendix E.)

28. If the Site, or any other real property where access and/or land/water use restrictions are needed, is owned or controlled by persons other than Performing Settling Defendant, Performing Settling Defendant shall use best efforts to secure from such persons:

a. An agreement substantially in the form of the access agreement exemplar attached as Appendix I to provide access thereto for the United States, DTSC, and Performing Settling Defendant, and their representatives, contractors, and subcontractors, to conduct any activity regarding the Consent Decree including, but not limited to, the activities listed in Paragraph 26.a; and

b. An agreement, enforceable by Performing Settling Defendant and DTSC, to refrain from using the Site, or such other real property, in any manner that DTSC, in consultation with EPA, determines will pose an unacceptable risk to human health or to the environment due to exposure to Waste Material or interfere with or adversely affect the implementation, integrity, or protectiveness of the Remedial Action. The agreement shall include, but not be limited to, the land/water use restrictions listed in Paragraph 26.b.

29. As used in this Section, "best efforts" means the efforts that a reasonable person in the position of Performing Settling Defendant would use so as to achieve the

goal in a timely manner, including the cost of employing professional assistance and the payment of reasonable sums of money to obtain access or agreement to restrict property use as describe in Paragraph 28. If Performing Settling Defendant is unable to accomplish what is required under Paragraph 28 through "best efforts" in a timely manner, Performing Settling Defendant shall notify DTSC, and include a description of the steps that Performing Settling Defendant has taken to comply with Paragraph 28. If DTSC deems it appropriate, it may assist Performing Settling Defendant, or take independent action, in obtaining access or agreements to restrict property use. All costs incurred by DTSC and the United States in providing such assistance or taking such action, including the cost of attorney time and the amount of monetary consideration or just compensation paid, constitute Future Response Costs (if incurred by the United States) or DTSC Future Response Costs (if incurred by DTSC) to be reimbursed under Section XVI (Payments for Response Costs).

30. If DTSC determines in a decision document prepared in accordance with the NCP, and approved by EPA, that additional Institutional Controls in the form of state or local laws, regulations, ordinances, zoning restrictions, or other governmental controls are needed at or in connection with the Site, Performing Settling Defendant shall cooperate with DTSC's and EPA's efforts to secure and ensure compliance with such Institutional Controls.

31. Notwithstanding any provision of the Consent Decree, the United States and DTSC retain all of their access authorities and rights, as well as all of their rights to

require Institutional Controls, including enforcement authorities related thereto, under CERCLA, RCRA, and any other applicable federal or state statute or regulations.

X. REPORTING REQUIREMENTS

32. In addition to any other requirement of this Consent Decree, Performing Settling Defendant shall submit to DTSC and EPA electronic copies of Semi-Annual Groundwater Monitoring Reports that: (a) describe the actions that have been taken toward achieving compliance with this Consent Decree during the previous six months; (b) include a summary of all results of sampling and tests and all other data received or generated by Performing Settling Defendant or its contractors or agents in the previous six months; (c) identify all plans, reports, and other deliverables required by this Consent Decree completed and submitted during the previous six months; (d) describe all actions, including, but not limited to, data collection and implementation of work plans, that are scheduled for the next six months and provide other information relating to the progress of the remediation; (e) include information regarding percentage of completion, unresolved delays encountered or anticipated that may affect the future schedule for implementation of the Work, and a description of efforts made to mitigate those delays or anticipated delays; and (f) include any modifications to the work plans or other schedules that Performing Settling Defendant has proposed to DTSC or that have been approved by DTSC. Performing Settling Defendant shall submit these Semi-Annual Groundwater Monitoring Reports to DTSC and EPA by the twenty-eighth day of February and the thirtieth day of August following the lodging of this Consent Decree until DTSC notifies Performing Settling Defendant pursuant to Paragraph 51 (Completion of the Work). If

requested by DTSC, in consultation with EPA, Performing Settling Defendant shall also provide briefings for DTSC and EPA to discuss the progress of the Work.

33. Performing Settling Defendant shall notify DTSC and EPA of any change in the schedule described in the Annual Groundwater Monitoring Report for the performance of any activity, including, but not limited to, data collection and implementation of work plans, no later than seven days prior to the performance of the activity.

34. Upon the occurrence of any event during performance of the Work that Performing Settling Defendant is required to report pursuant to Section 103 of CERCLA, 42 U.S.C. § 9603, or Section 304 of the Emergency Planning and Community Right-to-know Act ("EPCRA"), 42 U.S.C. § 11004, Performing Settling Defendant shall within 24 hours of the onset of such event orally notify the DTSC Project Manager or, in the event of the unavailability of the DTSC Project Manager, the EPA Project Coordinator. These reporting requirements are in addition to the reporting required by CERCLA Section 103 or EPCRA Section 304.

35. Within 20 days after the onset of such an event, Performing Settling Defendant shall furnish to DTSC and EPA a written report, signed by Performing Settling Defendant's Project Coordinator, setting forth the events that occurred and the measures taken, and to be taken, in response thereto. Within 30 days after the conclusion of such an event, Performing Settling Defendant shall submit a report setting forth all actions taken in response thereto.

36. Performing Settling Defendant shall submit electronic copies of all plans, reports, data, and other deliverables required by the SOW, the Remedial Cost Estimate, or any other approved plans to DTSC and EPA in accordance with the schedules set forth in such plans.

37. All deliverables submitted by Performing Settling Defendant to DTSC and EPA that purport to document Performing Settling Defendant's compliance with the terms of this Consent Decree shall be signed by an authorized representative of Performing Settling Defendant.

XI. DTSC APPROVAL OF PLANS, REPORTS, AND OTHER DELIVERABLES

38. Initial Submissions.

a. After review of any plan, report, or other deliverable that is required to be submitted for approval pursuant to this Consent Decree, DTSC, after reasonable opportunity for review and comment by EPA, shall: (1) approve, in whole or in part, the submission; (2) approve the submission upon specified conditions; (3) disapprove, in whole or in part, the submission; or (4) any combination of the foregoing.

b. DTSC also may modify the initial submission to cure deficiencies in the submission if: (1) DTSC determines that disapproving the submission and awaiting a resubmission would cause substantial disruption to the Work; or (2) previous submission(s) have been disapproved due to material defects and the deficiencies in the initial submission under consideration indicate a bad faith lack of effort to submit an acceptable plan, report, or deliverable.

39. Resubmissions. Upon receipt of a notice of disapproval under Paragraph 38.a.(3) or (4), or if required by a notice of approval upon specified conditions under Paragraph 38.a.(2), Performing Settling Defendant shall, within 10 days or such longer time as specified by DTSC in such notice, correct the deficiencies and resubmit the plan, report, or other deliverable for approval. After review of the resubmitted plan, report, or other deliverable, DTSC may: (a) approve, in whole or in part, the resubmission; (b) approve the resubmission upon specified conditions; (c) modify the resubmission; (d) disapprove, in whole or in part, the resubmission, requiring Performing Settling Defendant to correct the deficiencies; or (e) any combination of the foregoing.

40. Material Defects. If an initially submitted or resubmitted plan, report, or other deliverable contains a material defect, and the plan, report, or other deliverable is disapproved or modified by DTSC under Paragraph 38.b.(2) or 39 due to such material defect, then the material defect shall constitute a lack of compliance for purposes of Paragraph 39. The provisions of Section XIX (Dispute Resolution) and Section XX (Stipulated Penalties) shall govern the accrual and payment of any stipulated penalties regarding Performing Settling Defendant's submissions under this Section.

41. Implementation. Upon approval, approval upon conditions, or modification by DTSC under Paragraph 38 (Initial Submissions) or Paragraph 39 (Resubmissions), of any plan, report, or other deliverable, or any portion thereof: (a) such plan, report, or other deliverable, or portion thereof, shall be incorporated into and enforceable under this Consent Decree; and (b) Performing Settling Defendant shall take any action required by such plan, report, or other deliverable, or portion thereof, subject

only to its right to invoke the Dispute Resolution procedures set forth in Section XIX (Dispute Resolution) with respect to the modifications or conditions made by DTSC. The implementation of any non-deficient portion of a plan, report, or other deliverable submitted or resubmitted under Paragraph 38 or 39 shall not relieve Performing Settling Defendant of any liability for stipulated penalties under Section XX (Stipulated Penalties).

XII. PROJECT MANAGERS AND COORDINATORS

42. Within 20 days after lodging this Consent Decree, Performing Settling Defendant, DTSC and EPA will notify each other, in writing, of the name, address, telephone number, and email address of their respective designated Project Managers and Coordinators and Alternate Project Managers or Coordinators. If a Project Manager or Coordinator, or Alternate Project Manager or Coordinator, initially designated is changed, the identity of the successor will be given to the other Parties, excluding Settling Individuals, at least five working days before the change occurs, unless impracticable, but in no event later than the actual day the change is made. Performing Settling Defendant's Project Coordinator shall be subject to approval by DTSC and shall have the technical expertise sufficient to adequately oversee all aspects of the Work. Performing Settling Defendant's Project Coordinator shall not be an attorney for Performing Settling Defendant in this matter. The Project Coordinator designated by Performing Settling Defendant may assign other representatives, including other contractors, to serve as a Site representative for oversight of performance of daily operations during remedial activities.

43. Plaintiffs may designate other representatives, including, but not limited to, DTSC and EPA employees, and federal and DTSC contractors and consultants, to observe and monitor the progress of any activity undertaken pursuant to this Consent Decree. DTSC's Project Manager and Alternate Project Manager shall have the authority lawfully vested in a Remedial Project Manager ("RPM") and an On-Scene Coordinator ("OSC") by the NCP, 40 C.F.R. Part 300. DTSC's Project Manager under State law, or EPA's Project Coordinator or Alternate Project Coordinator, consistent with the NCP, shall have authority to halt any Work required by this Consent Decree and to take any necessary response action when he or she determines that conditions at the Site constitute an emergency situation or may present an immediate threat to public health or welfare or the environment due to release or threatened release of Waste Material.

44. DTSC's Project Manager and Performing Settling Defendant's Project Coordinator will meet at such times as required by DTSC.

XIII. PERFORMANCE GUARANTEE

45. In order to ensure the full and final completion of the Work, Performing Settling Defendant shall establish and maintain a performance guarantee in the amount of $976,063 as the current estimated cost of completing the Work for the benefit of DTSC and EPA. The performance guarantee, which must be satisfactory in form and substance to DTSC, shall be in the form of one or more of the following mechanisms (provided that, if Performing Settling Defendant intend to use multiple mechanisms, such multiple mechanisms shall be limited to surety bonds guaranteeing payment, letters of credit, trust funds, and insurance policies):

a. A surety bond unconditionally guaranteeing payment and/or performance of the Work that is issued by a surety company among those listed as acceptable sureties on federal bonds as set forth in Circular 570 of the U.S. Department of the Treasury;

b. One or more irrevocable letters of credit, payable to or at the direction of DTSC or EPA, whichever is lead Agency, that is issued by one or more financial institution(s) (1) that has the authority to issue letters of credit and (2) whose letter-of-credit operations are regulated and examined by a federal or state agency;

c. A trust fund established for the benefit of DTSC and EPA that is administered by a trustee (1) that has the authority to act as a trustee and (2) whose trust operations are regulated and examined by a federal or state agency;

d. A policy of insurance that (1) provides DTSC and EPA with acceptable rights as a beneficiary thereof; and (2) is issued by an insurance carrier (i) that has the authority to issue insurance policies in the applicable jurisdiction(s) and (ii) whose insurance operations are regulated and examined by a federal or state agency;

46. Performing Settling Defendant has selected, and DTSC has found satisfactory, as an initial performance guarantee a trust fund pursuant to Paragraph 45.c., in the form attached hereto as Appendix I. Within ten days after the Effective Date, Performing Settling Defendant shall execute or otherwise finalize all instruments or other documents required in order to make the selected performance guarantee(s) legally binding in a form substantially identical to the documents attached hereto as Appendix I,

and such performance guarantee(s) shall thereupon be fully effective. Upon its execution the performance guarantee shall supersede and replace the Custodian Fund Agreement, as amended. Within 30 days after the Effective Date, Performing Settling Defendant shall submit copies of all executed and/or otherwise finalized instruments or other documents required in order to make the selected performance guarantee(s) legally binding to the DTSC Project Manager and the EPA Regional Financial Management Officer in accordance with Section XXVII (Notices and Submissions), with a copy to the United States and EPA and DTSC as specified in Section XXVII.

47. In the event that DTSC, after reasonable opportunity for review and comment by EPA, determines at any time that a performance guarantee provided by Performing Settling Defendant pursuant to this Section is inadequate or otherwise no longer satisfies the requirements set forth in this Section, whether due to an increase in the estimated cost of completing the Work or for any other reason, or in the event that Performing Settling Defendant becomes aware of information indicating that a performance guarantee provided pursuant to this Section is inadequate or otherwise no longer satisfies the requirements set forth in this Section, whether due to an increase in the estimated cost of completing the Work or for any other reason, Performing Settling Defendant, within 30 days after receipt of notice of DTSC's determination or, as the case may be, within 30 days after Performing Settling Defendant became aware that the performance guarantee provided pursuant to this Section is inadequate or otherwise no longer satisfies the requirements set forth in this Section, shall obtain and present to DTSC for approval a proposal for a revised or alternative form of performance guarantee

listed in Paragraph 45 that satisfies all requirements set forth in this Section XIII; provided, however, that if Performing Settling Defendant cannot obtain such revised or alternative form of performance guarantee within such 30-day period, and provided further that Performing Settling Defendant shall have commenced to obtain such revised or alternative form of performance guarantee within such 30-day period, and thereafter diligently proceeds to obtain the same, DTSC shall extend such period for such time as is reasonably necessary for Performing Settling Defendant in the exercise of due diligence to obtain such revised or alternative form of performance guarantee, such additional period shall not exceed 60 days. On day 30, Performing Settling Defendant shall provide to DTSC a written status report on its efforts to obtain the revised or alternative form of guarantee. In seeking approval for a revised or alternative form of performance guarantee, Performing Settling Defendant shall follow the procedures set forth in Paragraph 49.b.(1). Performing Settling Defendant's inability to post a performance guarantee for completion of the Work shall in no way excuse performance of any other requirements of this Consent Decree, including, without limitation, the obligation of Performing Settling Defendant to complete the Work in strict accordance with the terms of this Consent Decree.

48. Funding for Work Takeover. The commencement of any Work Takeover pursuant to Paragraph 94 shall trigger DTSC and EPA's right to receive the benefit of any performance guarantee(s) provided pursuant to Paragraphs 45.a, 45.b, 45.c, or 45.d, and at such time DTSC and EPA shall have immediate access to resources guaranteed under any such performance guarantee(s), whether in cash or in kind, as needed to

continue and complete the Work assumed by DTSC and/or EPA under the Work Takeover. Upon the commencement of any Work Takeover, if (a) for any reason DTSC or EPA is unable to promptly secure the resources guaranteed under any such performance guarantee(s), whether in cash or in kind, necessary to continue and complete the Work assumed by DTSC and/or EPA under the Work Takeover, Performing Settling Defendant shall immediately upon written demand from DTSC or EPA deposit into a special account within the California Toxic Substances Control Account or such other account as DTSC or EPA may specify, in immediately available funds and without setoff, counterclaim, or condition of any kind, a cash amount up to but not exceeding the estimated cost of completing the Work as of such date, as determined by DTSC or EPA. In addition, if at any time DTSC or EPA is notified by the issuer of a performance guarantee that such issuer intends to cancel the performance guarantee mechanism it has issued then, unless Performing Settling Defendant provide a substitute performance guarantee mechanism in accordance with this Section XIII no later than 30 days prior to the impending cancellation date, DTSC or EPA shall be entitled (as of and after the date that is 30 days prior to the impending cancellation) to draw fully on the funds guaranteed under the then existing performance guarantee. All DTSC or EPA Work Takeover costs not reimbursed under this Paragraph shall be reimbursed under Section XVI (Payments for Response Costs).

49. <u>Modification of Amount and/or Form of Performance Guarantee</u>.

a. <u>Reduction of Amount of Performance Guarantee</u>. Except as set forth in Appendix I for payment from the Fund for Work performed, Performing Settling

Defendant may, no more than once during each calendar year following the first anniversary of the Effective Date, or at any other time agreed to by DTSC and Performing Settling Defendant, petition DTSC in writing to request a reduction in the amount of the performance guarantee provided pursuant to this Section so that the amount of the performance guarantee is equal to the estimated cost of completing the Work. Performing Settling Defendant shall submit a written proposal for such reduction to DTSC that shall specify, at a minimum, the estimated cost of completing the Work and the basis upon which such cost was calculated. In seeking approval for a reduction in the amount of the performance guarantee, Performing Settling Defendant shall follow the procedures set forth in Paragraph 49.b.(1) for requesting a revised or alternative form of performance guarantee, except as specifically provided in this Paragraph 49.a. If DTSC, after reasonable opportunity for review and comment by EPA, decides to accept Performing Settling Defendant's proposal for a reduction in the amount of the performance guarantee, either to the amount set forth in Performing Settling Defendant's written proposal or to some other amount as selected by DTSC, DTSC will notify Performing Settling Defendant of such decision in writing. Upon DTSC's written acceptance of a reduction in the amount of the performance guarantee, the estimated cost of work shall be deemed to be the estimated cost of completing the Work set forth in DTSC's written decision. After receiving DTSC's written decision, Performing Settling Defendant may reduce the amount of the performance guarantee in accordance with and to the extent permitted by such written acceptance and shall submit copies of all executed and/or otherwise finalized instruments or other documents required in order to make the

selected performance guarantee(s) legally binding in accordance with Paragraph 49.b.(1). In the event of a dispute, Performing Settling Defendant may reduce the amount of the performance guarantee required hereunder only in accordance with a final administrative or judicial decision resolving such dispute pursuant to Section XIX (Dispute Resolution). No change to the form or terms of any performance guarantee provided under this Section, other than a reduction in amount, is authorized except as provided in Paragraphs 47 and 49.b.

b. Change of Form of Performance Guarantee.

(1) If, after the Effective Date, Performing Settling Defendant desires to change the form or terms of any performance guarantee(s) provided pursuant to this Section, Performing Settling Defendant may, on any anniversary of the Effective Date, or at any other time agreed to by DTSC and Performing Settling Defendant, petition DTSC in writing to request a change in the form or terms of the performance guarantee provided hereunder. The submission of such proposed revised or alternative performance guarantee shall be as provided in Paragraph 49.b.(2). Any decision made by DTSC on a petition submitted under this Paragraph shall be made in DTSC's sole and unreviewable discretion, and such decision shall not be subject to challenge by Performing Settling Defendant pursuant to the dispute resolution provisions of this Consent Decree or in any other forum.

(2) Performing Settling Defendant shall submit a written proposal for a revised or alternative performance guarantee to DTSC that shall

specify, at a minimum, the estimated cost of completing the Work, the basis upon which such cost was calculated, and the proposed revised performance guarantee, including all proposed instruments or other documents required in order to make the proposed performance guarantee legally binding. The proposed revised or alternative performance guarantee must satisfy all requirements set forth or incorporated by reference in this Section. Performing Settling Defendant shall submit such proposed revised or alternative performance guarantee to the DTSC Project Manager in accordance with Section XXVII (Notices and Submissions). DTSC, after reasonable opportunity for review and comment by EPA, will notify Performing Settling Defendant in writing of its decision to accept or reject a revised or alternative performance guarantee submitted pursuant to this Paragraph. Within ten days after receiving a written decision approving the proposed revised or alternative performance guarantee, Performing Settling Defendant shall execute and/or otherwise finalize all instruments or other documents required in order to make the selected performance guarantee (s) legally binding in a form substantially identical to the documents submitted to DTSC as part of the proposal, and such performance guarantee (s) shall thereupon be fully effective. Performing Settling Defendant shall submit copies of all executed and/or otherwise finalized instruments or other documents required in order to make the selected performance guarantee(s) legally binding to the DTSC Project Manager within 30 days after receiving a written decision approving the proposed revised or alternative performance

guarantee(s) in accordance with Section XXVII (Notices and Submissions) and to the United States and EPA and DTSC as specified in Section XXVII.

c. Release of Performance Guarantee. Performing Settling Defendant shall not release, cancel, or discontinue any performance guarantee provided pursuant to this Section except as provided in this Paragraph. If Performing Settling Defendant receive written notice from DTSC in accordance with Paragraph 51 (Completion of the Work) that the Work has been fully and finally completed in accordance with the terms of this Consent Decree, or if DTSC otherwise so notifies Performing Settling Defendant in writing, Performing Settling Defendant may thereafter release, cancel, or discontinue the performance guarantee(s) provided pursuant to this Section. In the event of a dispute, Performing Settling Defendant may release, cancel, or discontinue the performance guarantee(s) required hereunder only in accordance with a final administrative or judicial decision resolving such dispute pursuant to Section XIX (Dispute Resolution).

XIV. CERTIFICATION OF COMPLETION

50. Completion of the Remedial Action.

a. Within 90 days after Performing Settling Defendant concludes that the Remedial Action has been fully performed and the Performance Standards have been achieved, Performing Settling Defendant shall schedule and conduct a pre-certification inspection to be attended by Performing Settling Defendant, DTSC and EPA. If, after the pre-certification inspection, Performing Settling Defendant still believes that the Remedial Action has been fully performed and the Performance Standards have been achieved, it shall submit a written report requesting certification to DTSC for approval,

with a copy to EPA, pursuant to Section XI (DTSC Approval of Plans, Reports, and Other Deliverables) within 30 days after the inspection. In the report, a registered professional engineer or a California-registered professional geologist and Performing Settling Defendant's Project Coordinator shall state that the Remedial Action has been completed in full satisfaction of the requirements of this Consent Decree. The written report shall include as-built drawings, if any, signed and stamped by a professional engineer or a professional geologist. The report shall contain the following statement, signed by a responsible corporate official of Performing Settling Defendant or Performing Settling Defendant's Project Coordinator:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If, after completion of the pre-certification inspection and receipt and review of the written report, DTSC, after reasonable opportunity for review and comment by EPA, determines that the Remedial Action or any portion thereof has not been completed in accordance with this Consent Decree or that the Performance Standards have not been

achieved, DTSC will notify Performing Settling Defendant in writing of the activities that must be undertaken by Performing Settling Defendant pursuant to this Consent Decree to complete the Remedial Action and achieve the Performance Standards. DTSC will set forth in the notice a schedule for performance of such activities consistent with the Consent Decree and the SOW or require Performing Settling Defendant to submit a schedule to DTSC for approval pursuant to Section XI (DTSC Approval of Plans, Reports, and Other Deliverables). Performing Settling Defendant shall perform all activities described in the notice in accordance with the specifications and schedules established pursuant to this Paragraph, subject to its right to invoke the dispute resolution procedures set forth in Section XIX (Dispute Resolution).

b. If DTSC concludes, based on the initial or any subsequent report requesting Certification of Completion of the Remedial Action and after a reasonable opportunity for review and comment by EPA, that the Remedial Action has been performed in accordance with this Consent Decree and that the Performance Standards have been achieved, DTSC will so certify in writing to Performing Settling Defendant. This certification shall constitute the Certification of Completion of the Remedial Action for purposes of this Consent Decree, including, but not limited to, Section XXI (Covenants by Plaintiffs for Performing Settling Defendant). Certification of Completion of the Remedial Action shall not affect Performing Settling Defendant's remaining obligations under this Consent Decree.

51. Completion of the Work.

a. Within 90 days after Performing Settling Defendant concludes that all phases of the Work, other than any remaining activities required under Section VII (Remedy Review), have been fully performed, Performing Settling Defendant shall schedule and conduct a pre-certification inspection to be attended by Performing Settling Defendant, DTSC and EPA. If, after the pre-certification inspection, Performing Settling Defendant still believes that the Work has been fully performed, Performing Settling Defendant shall submit a written report by a registered professional engineer or a California-registered professional geologist stating that the Work has been completed in full satisfaction of the requirements of this Consent Decree. The report shall contain the statement set forth in Paragraph 50.a, signed by a responsible corporate official of Performing Settling Defendant or Performing Settling Defendant's Project Coordinator. If, after review of the written report, DTSC, after reasonable opportunity for review and comment by EPA, determines that any portion of the Work has not been completed in accordance with this Consent Decree, DTSC will notify Performing Settling Defendant in writing of the activities that must be undertaken by Performing Settling Defendant pursuant to this Consent Decree to complete the Work, provided, however, that DTSC may only require Performing Settling Defendant to perform such activities pursuant to this Paragraph to the extent that such activities are consistent with the "scope of the remedy set forth in Remedial Cost Estimate," as that term is defined in Paragraph 14.a. DTSC will set forth in the notice a schedule for performance of such activities consistent with the Consent Decree and the SOW or require Performing Settling Defendant to submit a schedule to DTSC for approval pursuant to Section XI (DTSC Approval of

Plans, Reports, and Other Deliverables). Performing Settling Defendant shall perform all activities described in the notice in accordance with the specifications and schedules established therein, subject to its right to invoke the dispute resolution procedures set forth in Section XIX (Dispute Resolution).

b. If DTSC concludes, based on the initial or any subsequent request for Certification of Completion of the Work by Performing Settling Defendant and after a reasonable opportunity for review and comment by EPA, that the Work has been performed in accordance with this Consent Decree, DTSC will so notify Performing Settling Defendant in writing.

XV. EMERGENCY RESPONSE

52. If any event occurs during performance of the Work that causes or threatens to cause a release of Waste Material on, at, or from the Site and that either constitutes an emergency situation or that may present an immediate threat to public health or welfare or the environment, Performing Settling Defendant shall, subject to Paragraph 53, immediately take all appropriate action to prevent, abate, or minimize such release or threat of release, and shall immediately notify the DTSC Project Manager, or if the Project Manager is unavailable, DTSC's Branch Chief. If neither of these persons is available, Performing Settling Defendant shall notify the EPA Project Coordinator. Performing Settling Defendant shall take such actions in consultation with DTSC Project Manager or other available authorized DTSC employee, or as appropriate the EPA Project Coordinator, and in accordance with all applicable provisions of the Health and Safety Plans, the Contingency Plans, and any other applicable plans or documents

developed pursuant to the SOW. In the event that Performing Settling Defendant fails to take appropriate response action as required by this Section, and DTSC or, as appropriate, EPA, take such action instead, Performing Settling Defendant shall reimburse EPA and DTSC all costs of the response action under Section XVI (Payments for Response Costs).

53. Subject to Sections XXI (Covenants by Plaintiffs for Performing Settling Defendant) and XXII (Covenants by Plaintiffs for Settling Individuals), nothing in the preceding Paragraph or in this Consent Decree shall be deemed to limit any authority of DTSC or the United States (a) to take all appropriate action to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Material on, at, or from the Site; or (b) to direct or order such action, or seek an order from the Court, to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Material on, at, or from the Site.

XVI. PAYMENTS FOR DTSC AND UNITED STATES RESPONSE COSTS

54. Payments by Performing Settling Defendant for United States Past Response Costs, United States Future Response Costs and DTSC Future Response Costs.

a. Payment of United States Past Response Costs. Settling Performing Defendant shall continue to pay the United States Past Response Costs pursuant to the terms of paragraph 5 of the 1994 AOC, provided, however, that references in paragraph 5 of the 1994 AOC to any other paragraphs or provisions of the 1994 AOC are no longer applicable, and are substituted with the following clarifications: Upon approval by DTSC, after a reasonable opportunity for review and comment by

EPA, of the Post Closure confirmatory soil sampling reporting deliverable as required by the Statement of Work (which shall constitute "completion of the soil remediation at the Site" for purposes of paragraph 5 of the 1994 AOC), EPA will send Performing Settling Defendant a bill requiring payment of all unreimbursed United States Past Response Costs that includes a SCORPIOS (EPA's "Superfund Cost Recovery Package Imaging and On-line System") cost summary report, which includes direct and indirect costs incurred by EPA, its contractors, and DOJ. Performing Settling Defendant shall make all payments within 30 days after Performing Settling Defendant's receipt of each bill requiring payment, except as otherwise provided in Paragraph 56, in accordance with Paragraph 55.a. The total amount to be paid by Performing Settling Defendant pursuant to this Paragraph 54.a shall be deposited by EPA in the Coast Wood Preserving Special Account (SSID 0945) to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the EPA Hazardous Substance Superfund. In the event of any conflict between this Consent Decree and the 1994 AOC, this Consent Decree shall control.

b. Payment of United States Future Response Costs. Performing Settling Defendant shall pay to EPA all Future Response Costs not inconsistent with the NCP. On a periodic basis, which will begin on an annual-billing cycle, EPA will send Performing Settling Defendant a bill requiring payment that includes a SCORPIOS cost summary report which includes direct and indirect costs incurred by EPA, its contractors, and DOJ. Performing Settling Defendant shall make all payments within 30 days after Performing Settling Defendant's receipt of each bill requiring payment, except as

otherwise provided in Paragraph 56, in accordance with Paragraph 55.a. The total amount to be paid by Performing Settling Defendant to EPA pursuant to this Paragraph 54.b. shall be deposited by EPA in the Coast Wood Preserving Special Account (SSID 0945) to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the EPA Hazardous Substance Superfund.

c. Payment of DTSC Future Response Costs. Performing Settling Defendant shall pay to DTSC all DTSC Future Response Costs not inconsistent with the NCP. DTSC will send Performing Settling Defendant a bill requiring payment that includes a DTSC-prepared cost summary, which includes direct and indirect costs incurred by DTSC and its contractors and subcontractors on a periodic basis. Performing Settling Defendant shall make all payments within 30 days after its receipt of each bill requiring payment, except as otherwise provide in Paragraph 56. DTSC Interest accrues from the billing date on any balances that remain unpaid after 60 days from billing.

55. Payment Instructions for Performing Settling Defendant.

a. Payments to EPA. All payments required to EPA under this Consent Decree shall be made by Fedwire EFT to:

Federal Reserve Bank of New York
ABA = 021030004
Account = 68010727
SWIFT address = FRNYUS33
33 Liberty Street
New York NY 10045
Field Tag 4200 of the Fedwire message should read "D 68010727 Environmental Protection Agency"

and shall reference the CDCS Number, Site/Spill ID Number (SSID) 0945, and DOJ Case Number. At the time of any payment required to be made to EPA under this Consent Decree, Performing Settling Defendant shall send notice that payment has been made to the United States, and to EPA, in accordance with Section XXVII (Notices and Submissions), and to the EPA Cincinnati Finance Office by email at cinwd_acctsreceivable@epa.gov, or by mail at 26 Martin Luther King Drive, Cincinnati, Ohio 45268. Such notice shall also reference the CDCS Number, Site/Spill ID Number, and DOJ Case Number.

b. Payments to DTSC. All payments required to DTSC under this Consent Decree shall be made payable to:

Cashier
Department of Toxic Substances Control
Accounting Office, MS-21A
1001 I Street
P.O. Box 806
Sacramento, CA 95812-0806

and shall bear on its fact both the docket number of this action, and the phrase "Site Code" [200021]. A copy of each payment to DTSC shall be mailed to:

Lynn Goldman
Office of Legal Counsel
California Department of Toxic Substances Control
1001 I Street, 23rd Floor
P.O. Box 806
Sacramento, CA 95812-0806

Or e-mailed to Lynn.Goldman@dtsc.ca.govmailto: in .pdf or .jpg. format.

56. Contested United States Future Response Costs, United States Past Response Costs, and DTSC Future Response Costs.

a. Procedure for Contesting United States Future Response Costs and United States Past Response Costs. Performing Settling Defendant may contest any United States Future Response Costs and United States Past Response Costs that are billed by EPA under Paragraphs 54.b. (Payments by Performing Settling Defendant for United States Future Response Costs) and Paragraph 54.a. (Payment by Performing Settling Defendant for United States Past Response Costs) if it determines that EPA has made a mathematical error or included a cost item that is not within the definition of United States Future Response Costs or United States Past Response Costs, or if it believes EPA incurred excess costs as a direct result of an EPA action that was inconsistent with a specific provision or provisions of the NCP. Such objection shall be made in writing within 30 days after receipt of the bill and must be sent to the United States pursuant to Section XXVII (Notices and Submissions). Any such objection shall specifically identify the contested Future Response Costs and the basis for objection. In the event of an objection, Performing Settling Defendant shall pay all uncontested United States Future Response Costs or United States Past Response Costs to the United States within 30 days after Performing Settling Defendant's receipt of the bill requiring payment. Simultaneously, Performing Settling Defendant shall establish, in a duly chartered bank or trust company, an interest-bearing escrow account that is insured by the Federal Deposit Insurance Corporation ("FDIC"), and remit to that escrow account funds equivalent to the amount of the contested United States Future Response Costs or United

States Past Response Costs. Performing Settling Defendant shall send to the United States, as provided in Section XXVII (Notices and Submissions), a copy of the transmittal letter and check paying the uncontested United States Future Response Costs or United States Past Response Costs, and a copy of the correspondence that establishes and funds the escrow account, including, but not limited to, information containing the identity of the bank and bank account under which the escrow account is established as well as a bank statement showing the initial balance of the escrow account. Simultaneously with establishment of the escrow account, Performing Settling Defendant shall initiate the Dispute Resolution procedures in Section XIX (Dispute Resolution). If the United States prevails in the dispute, Performing Settling Defendant shall pay the sums due (with accrued interest) to the United States within five working days after the resolution of the dispute. If Performing Settling Defendant prevails concerning any aspect of the contested costs, Performing Settling Defendant shall pay that portion of the costs (plus associated accrued interest) for which it did not prevail to the United States within five working days after the resolution of the dispute. Performing Settling Defendant shall be disbursed any balance of the escrow account. All payments to the United States under this Paragraph shall be made in accordance with Paragraph 55.a.

b. Procedure for Contesting DTSC Future Response Costs. If Performing Settling Defendant disputes a DTSC billing, or any part thereof, Performing Settling Defendant shall notify DTSC's assigned project manager and attempt to informally resolve the dispute with DTSC's project manager and branch chief. If Performing Settling Defendant desires to formally request dispute resolution with regard

to the billing, Performing Settling Defendant shall submit to DTSC a request for dispute resolution in writing within 45 days of receipt of the billing in dispute. The written request shall describe all issues in dispute and shall set forth the reasons for the dispute, both factual and legal. If the dispute pertains only to a portion of the costs included in the invoice, Performing Settling Defendant shall pay all costs which are undisputed in accordance with Paragraph 55.b. The filing of a notice of dispute pursuant to this Paragraph shall not stay the accrual of DTSC Interest on any unpaid costs pending resolution of the dispute. The written request shall be sent to:

Chief, Collections and Resolution Unit
Department of Toxic Substances Control
PO Box 806
Sacramento, CA 96812-0806

A copy of the written request for dispute resolution shall also be sent to the person designated by DTSC to receive submittals under this Consent Decree. A decision on the billing dispute will be rendered by the Chief, Collections and Resolution Unit, or other DTSC designee.

c. The dispute resolution procedures set forth in this Paragraph in conjunction with the procedures set forth in Section XIX (Dispute Resolution) shall be the exclusive mechanisms for resolving disputes regarding Performing Settling Defendant's obligation to reimburse the United States for its Future Response Costs or DTSC for its DTSC Future Response Costs.

XVII. INDEMNIFICATION AND INSURANCE

57. Performing Settling Defendant's Indemnification of the United States and DTSC.

a. The United States and DTSC do not assume any liability by entering into this Consent Decree or by virtue of any designation of Performing Settling Defendant as EPA's authorized representative under Section 104(e) of CERCLA, 42 U.S.C. § 9604(e). Performing Settling Defendant shall indemnify, save and hold harmless the United States and DTSC, and their respective officials, agents, employees, contractors, subcontractors, and representatives for or from any and all claims or causes of action arising from, or on account of, negligent or other wrongful acts or omissions of Performing Settling Defendant, its officers, directors, employees, agents, contractors, subcontractors, and any persons acting on its behalf or under its control, in carrying out activities pursuant to this Consent Decree, including, but not limited to, any claims arising from any designation of Performing Settling Defendant as EPA's authorized representatives under Section 104(e) of CERCLA. Further, Performing Settling Defendant agrees to pay the United States and DTSC all costs they incur including, but not limited to, attorneys' fees and other expenses of litigation and settlement arising from, or on account of, claims made against the United States or DTSC based on negligent or other wrongful acts or omissions of Performing Settling Defendant, its officers, directors, employees, agents, contractors, subcontractors, and any persons acting on its behalf or under its control, in carrying out activities pursuant to this Consent Decree. Neither the United States nor DTSC shall be held out as a party to any contract

entered into by or on behalf of Performing Settling Defendant in carrying out activities pursuant to this Consent Decree. Neither Performing Settling Defendant nor any such contractor shall be considered an agent of the United States or DTSC.

b. DTSC and/or the United States shall give Performing Settling Defendant notice of any claim for which the DTSC and/or the United States plans to seek indemnification pursuant to this Paragraph, and shall consult with Performing Settling Defendant prior to settling such claim.

58. Performing Settling Defendant covenants not to sue and agrees not to assert any claims or causes of action against the DTSC and/or the United States for damages or reimbursement or for set-off of any payments made or to be made to the United States or DTSC, arising from or on account of any contract, agreement, or arrangement between Performing Settling Defendant and any person for performance of Work on or relating to the Site, including, but not limited to, claims on account of construction delays. In addition, Performing Settling Defendant shall indemnify and hold harmless the United States and DTSC with respect to any and all claims for damages or reimbursement arising from or on account of any contract, agreement, or arrangement between Performing Settling Defendant and any person for performance of Work on or relating to the Site, including, but not limited to, claims on account of construction delays.

59. No later than 15 days before commencing any on-Site Work, Performing Settling Defendant shall secure, and shall maintain until the first anniversary after issuance of the Certification of Completion of the Remedial Action pursuant to Paragraph

50 of Section XIV (Certification of Completion), commercial general liability insurance with limits of $1 million, for any one occurrence, and automobile liability insurance with limits of $1 million, combined single limit, naming the United States and DTSC as additional insureds with respect to all liability arising out of the activities performed by or on behalf of Performing Settling Defendant pursuant to this Consent Decree. In addition, for the duration of this Consent Decree, Performing Settling Defendant shall satisfy, or shall ensure that its contractors or subcontractors satisfy, all applicable laws and regulations regarding the provision of worker's compensation insurance for all persons performing the Work on behalf of Performing Settling Defendant in furtherance of this Consent Decree. Prior to commencement of the Work under this Consent Decree, Performing Settling Defendant shall provide to DTSC and EPA certificates of such insurance and a copy of each insurance policy. Performing Settling Defendant shall resubmit such certificates and copies of policies each year on the anniversary of the Effective Date. If Performing Settling Defendant demonstrates by evidence satisfactory to DTSC, with reasonable opportunity for review and comment by EPA, that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering the same risks but in a lesser amount, then, with respect to that contractor or subcontractor, Performing Settling Defendant need provide only that portion of the insurance described above that is not maintained by the contractor or subcontractor.

XVIII. FORCE MAJEURE

60. "Force majeure," for purposes of this Consent Decree, is defined as any event arising from causes beyond the control of Performing Settling Defendant, of any entity controlled by Performing Settling Defendant, or of Performing Settling Defendant's contractors that delays or prevents the performance of any obligation under this Consent Decree despite Performing Settling Defendant's best efforts to fulfill the obligation. The requirement that Performing Settling Defendant exercise "best efforts to fulfill the obligation" includes using best efforts to anticipate any potential force majeure and best efforts to address the effects of any potential force majeure (a) as it is occurring and (b) following the potential force majeure such that the delay and any adverse effects of the delay are minimized to the greatest extent possible. "Force majeure" does not include financial inability to complete the Work or a failure to achieve the Performance Standards.

61. If any event occurs or has occurred that may delay the performance of any obligation under this Consent Decree for which Performing Settling Defendant intends or may intend to assert a claim of force majeure, Performing Settling Defendant shall notify DTSC's Project Manager orally or, in his or her absence, DTSC's Branch Chief, within 24 hours of when Performing Settling Defendant first knew that the event might cause a delay. Within seven days thereafter, Performing Settling Defendant shall provide in writing to DTSC and EPA an explanation and description of the reasons for the delay; the anticipated duration of the delay; all actions taken or to be taken to prevent or minimize the delay; a schedule for implementation of any measures to be taken to prevent or

mitigate the delay or the effect of the delay; Performing Settling Defendant's rationale for attributing such delay to a force majeure; and a statement as to whether, in the opinion of Performing Settling Defendant, such event may cause or contribute to an endangerment to public health or welfare, or the environment. Performing Settling Defendant shall include with any notice all available documentation supporting its claim that the delay was attributable to a force majeure. Performing Settling Defendant shall be deemed to know of any circumstance of which Performing Settling Defendant, any entity controlled by Performing Settling Defendant, or Performing Settling Defendant's contractors knew or should have known. Failure to comply with the above requirements regarding an event shall preclude Performing Settling Defendant from asserting any claim of force majeure regarding that event, provided, however, that if DTSC, despite the late notice, is able to assess to its satisfaction whether the event is a force majeure under Paragraph 60 and whether Performing Settling Defendant have exercised their best efforts under Paragraph 60, DTSC may, in its unreviewable discretion, excuse in writing Performing Settling Defendant's failure to submit timely notices under this Paragraph.

62. If DTSC, after a reasonable opportunity for review and comment by EPA, agrees that the delay or anticipated delay is attributable to a force majeure, the time for performance of the obligations under this Consent Decree that are affected by the force majeure will be extended by DTSC, after a reasonable opportunity for review and comment by EPA, for such time as is necessary to complete those obligations. An extension of the time for performance of the obligations affected by the force majeure shall not, of itself, extend the time for performance of any other obligation. If DTSC,

after a reasonable opportunity for review and comment by EPA, does not agree that the delay or anticipated delay has been or will be caused by a force majeure, DTSC will notify Performing Settling Defendant in writing of its decision. If DTSC, after a reasonable opportunity for review and comment by EPA, agrees that the delay is attributable to a force majeure, DTSC will notify Performing Settling Defendant in writing of the length of the extension, if any, for performance of the obligations affected by the force majeure.

63. If Performing Settling Defendant elects to invoke the dispute resolution procedures set forth in Section XIX (Dispute Resolution), it shall do so no later than 15 days after receipt of DTSC's notice. In any such proceeding, Performing Settling Defendant shall have the burden of demonstrating by a preponderance of the evidence that the delay or anticipated delay has been or will be caused by a force majeure, that the duration of the delay or the extension sought was or will be warranted under the circumstances, that best efforts were exercised to avoid and mitigate the effects of the delay, and that Performing Settling Defendant complied with the requirements of Paragraphs 60 and 61. If Performing Settling Defendant carries this burden, the delay at issue shall be deemed not to be a violation by Performing Settling Defendant of the affected obligation of this Consent Decree identified to DTSC and the Court.

XIX. DISPUTE RESOLUTION

64. Unless otherwise expressly provided for in this Consent Decree, the dispute resolution procedures of this Section shall be the exclusive mechanism to resolve disputes regarding this Consent Decree. However, the procedures set forth in this Section

shall not apply to actions by the United States to enforce obligations of Performing Settling Defendant that have not been disputed in accordance with this Section. Paragraphs 65 through 69 shall govern disputes between Performing Settling Defendants and the United States. Paragraphs 70 through 74 shall govern disputes between Performing Settling Defendants and DTSC.

65. Any dispute regarding this Consent Decree shall in the first instance be the subject of informal negotiations between the parties to the dispute. The period for informal negotiations shall not exceed 20 days from the time the dispute arises, unless it is modified by written agreement of the parties to the dispute. The dispute shall be considered to have arisen when one party sends the other parties a written Notice of Dispute.

66. Statements of Position.

a. In the event that the parties cannot resolve a dispute by informal negotiations under the preceding Paragraph, then the position advanced by EPA shall be considered binding unless, within 30 days after the conclusion of the informal negotiation period, Performing Settling Defendant invoke the formal dispute resolution procedures of this Section by serving on the United States a written Statement of Position on the matter in dispute, including, but not limited to, any factual data, analysis, or opinion supporting that position and any supporting documentation relied upon by Performing Settling Defendant. The Statement of Position shall specify Performing Settling Defendant's position as to whether formal dispute resolution should proceed under Paragraph 67

(Record Review) or 68. The Statement of Position shall be provided to DTSC for informational purposes as a courtesy at the time it is served on the United States.

b. Within 30 days after receipt of Performing Settling Defendant's Statement of Position, EPA will serve on Performing Settling Defendant its Statement of Position, including, but not limited to, any factual data, analysis, or opinion supporting that position and all supporting documentation relied upon by EPA. EPA's Statement of Position shall include a statement as to whether formal dispute resolution should proceed under Paragraph 67 (Record Review) or Paragraph 68. Within 15 days after receipt of EPA's Statement of Position, Performing Settling Defendant may submit a Reply. The United States' Statement of Position shall be provided to DTSC for informational purposes as a courtesy at the time it is served on the Performing Settling Defendant. Performing Settling Defendant's Reply shall be provided to DTSC for informational purposes as a courtesy at the time it is served on the United States.

c. If there is disagreement between EPA and Performing Settling Defendant as to whether dispute resolution should proceed under Paragraph 67 (Record Review) or 68, the parties to the dispute shall follow the procedures set forth in the paragraph determined by EPA to be applicable. However, if Performing Settling Defendant ultimately appeals to the Court to resolve the dispute, the Court shall determine which paragraph is applicable in accordance with the standards of applicability set forth in Paragraphs 67 and 68.

67. Record Review. Formal dispute resolution for disputes pertaining to the selection or adequacy of any response action and all other disputes that are accorded

review on the administrative record under applicable principles of administrative law shall be conducted pursuant to the procedures set forth in this Paragraph. For purposes of this Paragraph, the adequacy of any response action includes, without limitation, the adequacy or appropriateness of plans, procedures to implement plans, or any other items requiring approval by EPA under this Consent Decree, and the adequacy of the performance of response actions taken pursuant to this Consent Decree. Nothing in this Consent Decree shall be construed to allow any dispute by Performing Settling Defendant regarding the validity of Remedial Cost Estimate's provisions.

a. An administrative record of the dispute shall be maintained by EPA and shall contain all statements of position, including supporting documentation, submitted pursuant to this Section. Where appropriate, EPA may allow submission of supplemental statements of position by the parties to the dispute.

b. The Director of the Superfund Division, EPA Region IX, will issue a final administrative decision resolving the dispute based on the administrative record described in Paragraph 67. This decision shall be binding upon Performing Settling Defendant, subject only to the right to seek judicial review pursuant to Paragraphs 67 and 68.

c. Any administrative decision made by EPA pursuant to Paragraph 67 shall be reviewable by this Court, provided that a motion for judicial review of the decision is filed by Performing Settling Defendant with the Court and served on the United States and EPA within ten days after receipt of EPA's decision. The motion shall include a description of the matter in dispute, the efforts made by the parties to resolve it,

the relief requested, and the schedule, if any, within which the dispute must be resolved to ensure orderly implementation of this Consent Decree. The United States may file a response to Performing Settling Defendant's motion.

d. In proceedings on any dispute governed by this Paragraph, Performing Settling Defendant shall have the burden of demonstrating that the decision of the Superfund Division Director is arbitrary and capricious or otherwise not in accordance with law. Judicial review of EPA's decision shall be on the administrative record compiled pursuant to Paragraph 67.

68. Formal dispute resolution for disputes that neither pertain to the selection or adequacy of any response action nor are otherwise accorded review on the administrative record under applicable principles of administrative law, shall be governed by this Paragraph.

a. Following receipt of Performing Settling Defendant's Statement of Position submitted pursuant to Paragraph 66, the Director of the Superfund Division, EPA Region IX, will issue a final decision resolving the dispute. The Superfund Division Director's decision shall be binding on Performing Settling Defendant unless, within ten days after receipt of the decision, Performing Settling Defendant files with the Court and serve on the parties a motion for judicial review of the decision setting forth the matter in dispute, the efforts made by the parties to resolve it, the relief requested, and the schedule, if any, within which the dispute must be resolved to ensure orderly implementation of the Consent Decree. The United States may file a response to Performing Settling Defendant's motion.

b. Notwithstanding Paragraph S (CERCLA Section 113(j) Record Review of Remedial Cost Estimate and Work) of Section I (Background), judicial review of any dispute governed by this Paragraph shall be governed by applicable principles of law.

69. The invocation of formal dispute resolution procedures under this Section shall not extend, postpone, or affect in any way any obligation of Performing Settling Defendant under this Consent Decree, not directly in dispute, unless EPA agrees or the Court orders otherwise. Stipulated penalties with respect to the disputed matter shall continue to accrue but payment shall be stayed pending resolution of the dispute as provided in Paragraph 80. Notwithstanding the stay of payment, stipulated penalties shall accrue from the first day of noncompliance with any applicable provision of this Consent Decree. In the event that Performing Settling Defendant does not prevail on the disputed issue, stipulated penalties shall be assessed and paid as provided in Section XX (Stipulated Penalties).

70. DTSC Dispute Resolution Procedures. Any dispute regarding this Consent Decree between Performing Settling Defendant and DTSC shall in the first instance be the subject of informal negotiations between the parties to the dispute. The period for informal negotiations shall not exceed 20 days from the time the dispute arises, unless it is modified by written agreement of both Performing Settling Defendant and DTSC. The dispute shall be considered to have arisen when Performing Settling Defendant or DTSC sends the other party a written Notice of Dispute by Certified Mail with Return Receipt requested. An advance copy of this Notice of Dispute (to be sent by

Certified Mail) shall be sent by electronic mail to the person identified in Section XXVII (Notices and Submissions) at the time the letter is mailed. However, the 20-day period will not begin to run until actual receipt of the Certified Mail Return Receipt. The informal dispute resolution will have concluded upon 20 days from the date of receipt of the written Notice of Dispute, or such modified time agreed to in writing by the parties.

71. Statements of Position.

a. In the event that the dispute cannot be resolved by informal negotiations under Paragraph 70, then the position advanced by DTSC shall be considered binding unless, within 30 days after the conclusion of the informal negotiation period, Performing Settling Defendant invokes the formal dispute resolution procedures of this Section by serving on DTSC a written Statement of Position on the matter in dispute, including, but not limited to, any factual data, analysis, or opinion supporting that position and any supporting documentation relied upon by Performing Settling Defendant. The Statement of Position shall specify Performing Settling Defendant's position as to whether formal dispute resolution should proceed under Paragraph 72 (Record Review) or Paragraph 73. The Statement of Position shall be provided to the United States for informational purposes as a courtesy at the time it is served on DTSC.

b. Within 30 days after receipt of Performing Settling Defendant's Statement of Position, DTSC will serve on Performing Settling Defendant its Statement of Position, including, but not limited to, any factual data, analysis, or opinion supporting that position and all supporting documentation relied upon by DTSC. DTSC's Statement of Position shall include a statement as to whether formal dispute resolution should

proceed under Paragraph 72 (Record Review) or Paragraph 73. DTSC's Statement of Position shall be provided to the United States for informational purposes as a courtesy at the time it is served on Performing Settling Defendant. Within 15 days after receipt of DTSC's Statement of Position, Performing Settling Defendant may submit a Reply to DTSC with an informational copy to the United States.

c. If there is disagreement between Performing Settling Defendant and DTSC as to whether dispute resolution should proceed under Paragraph 72 (Record Review) or Paragraph 73, the parties to the dispute shall follow the procedures set forth in the paragraph determined by DTSC to be applicable shall be followed. However, if Performing Settling Defendant ultimately appeals to the Court to resolve the dispute, the Court shall determine which paragraph is applicable, in accordance with the standards of applicability set forth in Paragraphs 72 (Record Review) and Paragraph 73.

72. Record Review. Formal dispute resolution for disputes pertaining to the selection or adequacy of any response action shall be conducted pursuant to the procedures set forth in this Paragraph under the administrative record and pursuant to CERCLA. All other disputes that are accorded review on the administrative record under applicable principles of administrative law shall be conducted pursuant to the procedures set forth in this Paragraph. For purposes of this Paragraph, the adequacy of any response action includes, without limitation, the adequacy or appropriateness of plans, procedures to implement plans, or any other items requiring approval by DTSC under this Consent Decree, and the adequacy of the performance of response actions taken pursuant to this Consent Decree. Nothing in this Consent Decree shall be construed to allow any dispute

by Performing Settling Defendant regarding the validity of the Remedial Cost Estimate provisions.

a. An administrative record of the dispute shall be maintained by DTSC and shall contain all statements of position, including supporting documentation, submitted pursuant to this Section. Where appropriate, DTSC, at its sole discretion, may allow submission of supplemental statements of position by the parties to the dispute.

b. The Director of DTSC will issue a final administrative decision resolving the dispute based on the administrative record described in this Paragraph. This decision shall be binding upon Performing Settling Defendant, subject only to the right to seek judicial review pursuant to this Paragraph and Paragraph 73.

c. Provided that a motion for judicial review of the decision is filed by Performing Settling Defendant with the Court and served on DTSC within ten days after receipt of DTSC's decision (with an informational copy provided to the United States), any administrative decision made by DTSC pursuant to this Paragraph shall be reviewable by this Court. The motion shall include a description of the matter in dispute, the efforts made by the parties to resolve it, the relief requested, and the schedule, if any, within which the dispute must be resolved to ensure orderly implementation of this Consent Decree. DTSC may file a response to Performing Settling Defendant's motion.

d. In proceedings on any dispute governed by this Paragraph, Performing Settling Defendant shall have the burden of demonstrating that the decision of DTSC is arbitrary and capricious or otherwise not in accordance with law. Judicial

review of DTSC's decision shall be on the administrative record compiled pursuant to this Paragraph.

73. Formal dispute resolution for disputes that do not pertain to either the selection or the adequacy of any response action, or are otherwise not accorded review on the administrative record under applicable principles of California administrative law, shall be governed by this Paragraph.

a. Following receipt of Performing Settling Defendant's Statement of Position submitted pursuant to Paragraph 71, the Director of DTSC will issue a final decision resolving the dispute. The DTSC Director's decision shall be binding on Performing Settling Defendant unless, within ten days after receipt of the decision, Performing Settling Defendant files with the Court and serves on DTSC a motion for judicial review of the decision setting forth the matter in dispute, the efforts made by the parties to resolve it, the relief requested, and the schedule, if any, within which the dispute must be resolved to ensure orderly implementation of the Consent Decree. DTSC may file a response to Performing Settling Defendant's motion. Both Performing Settling Defendant and DTSC shall provide the United States with copies of their respective filings at the time of filing.

b. Notwithstanding Paragraph S (CERCLA Section 113(j) Record Review of Remedial Cost Estimate and Work) of Section I (Background), judicial review of any dispute governed by this Paragraph shall be governed by applicable principles of law.

74. The invocation of formal dispute resolution procedures under this Section shall not extend, postpone, or affect in any way any obligation of Performing Settling Defendant under this Consent Decree, not directly in dispute, unless DTSC agrees or the Court orders otherwise. Stipulated penalties with respect to the disputed matter shall continue to accrue, but payment shall be stayed pending resolution of the dispute as provided in Paragraph 81. Notwithstanding the stay of payment, stipulated penalties shall accrue from the first day of noncompliance with any applicable provision of this Consent Decree. In the event that Performing Settling Defendant does not prevail on the disputed issue, stipulated penalties shall be assessed and paid as provided in Section XX (Stipulated Penalties).

XX. STIPULATED PENALTIES

75. Stipulated Penalties for Failure to Comply with Consent Decree. Performing Settling Defendant shall be liable for stipulated penalties to DTSC in the amounts set forth below for failure to comply with the requirements of this Consent Decree, unless excused under Section XVIII (Force Majeure). "Compliance" by Performing Settling Defendant shall include completion of all payments and activities required under this Consent Decree, or any plan, report, or other deliverable approved under this Consent Decree, in accordance with all applicable requirements of law, this Consent Decree, the SOW, and any plans, reports, or other deliverables approved under this Consent Decree and within the specified time schedules established by and approved under this Consent Decree. The following stipulated penalties shall accrue per violation per day for any failure to comply with the requirements of this Consent Decree:

Penalty Per Violation Per Day	Period of Noncompliance
$100	1st through 14th day
$250	15th through 30th day
$500	31st day and beyond

76. Stipulated Penalty for Work Takeover. In the event that DTSC or EPA assumes performance of a portion or all of the Work pursuant to Paragraph 94 (Work Takeover), Performing Settling Defendant shall be liable for a stipulated penalty in the amount of $20,000. Stipulated penalties under this Paragraph are in addition to the remedies available under Paragraphs 48 (Funding for Work Takeover) and 94 (Work Takeover).

77. All penalties shall begin to accrue on the day after the complete performance is due or the day a violation occurs and shall continue to accrue through the final day of the correction of the noncompliance or completion of the activity. However, stipulated penalties shall not accrue: (a) with respect to a deficient submission under Section XI (DTSC Approval of Plans, Reports, and Other Deliverables), during the period, if any, beginning on the 31st day after DTSC's receipt of such submission until the date that DTSC notifies Performing Settling Defendant of any deficiency; (b) with respect to a decision by DTSC, under Paragraph 72.b. or 73.a. of Section XIX (Dispute Resolution), during the period, if any, beginning on the 21st day after the date that Performing Settling Defendant's reply to DTSC's Statement of Position is received until the date that the Director issues a final decision regarding such dispute; or (c) with respect to judicial review by this Court of any dispute under Section XIX (Dispute

Resolution), during the period, if any, beginning on the 31st day after the Court's receipt of the final submission regarding the dispute until the date that the Court issues a final decision regarding such dispute. Nothing in this Consent Decree shall prevent the simultaneous accrual of separate penalties for separate violations of this Consent Decree.

78. Following DTSC's determination that Performing Settling Defendant has failed to comply with a requirement of this Consent Decree, DTSC may give Performing Settling Defendant written notification of the same and describe the noncompliance. DTSC may send Performing Settling Defendant a written demand for the payment of the penalties. However, penalties shall accrue as provided in the preceding Paragraph regardless of whether DTSC has notified Performing Settling Defendant of a violation.

79. All penalties accruing under this Section shall be due and payable to DTSC within 30 days after Performing Settling Defendant's receipt from DTSC of a demand for payment of the penalties, unless Performing Settling Defendant invokes the Dispute Resolution procedures under Section XIX (Dispute Resolution) within the 30-day period. All payments to DTSC under this Section shall indicate that the payment is for stipulated penalties and shall be made in accordance with Paragraph 55.b.

80. Penalties shall continue to accrue as provided in Paragraph 77 during any dispute resolution period, but need not be paid until the following:

a. If the dispute is resolved by agreement of the parties or by a decision of DTSC that is not appealed to this Court, accrued penalties determined to be

owed shall be paid to DTSC within 15 days after the agreement or the receipt of DTSC's decision or order;

b. If the dispute is appealed to this Court and DTSC prevails in whole or in part, Performing Settling Defendant shall pay all accrued penalties determined by the Court to be owed to DTSC within 60 days after receipt of the Court's decision or order, except as provided in Paragraph 80; and

c. If the District Court's decision is appealed by any Party, Performing Settling Defendant shall pay all accrued penalties determined by the District Court to be owed to DTSC into an interest-bearing escrow account, established at a duly chartered bank or trust company that is insured by the FDIC, within 60 days after receipt of the Court's decision or order. Penalties shall be paid into this account as they continue to accrue, at least every 60 days. Within 15 days after receipt of the final appellate court decision, the escrow agent shall pay the balance of the account to DTSC or to Performing Settling Defendant to the extent that they prevail.

81. If Performing Settling Defendant fails to pay stipulated penalties when due, Performing Settling Defendant shall pay DTSC Interest on the unpaid stipulated penalties as follows: (a) if Performing Settling Defendant has timely invoked dispute resolution such that the obligation to pay stipulated penalties has been stayed pending the outcome of dispute resolution, DTSC Interest shall accrue from the date stipulated penalties are due pursuant to Paragraph 80 until the date of payment; and (b) if Performing Settling Defendant fails to timely invoke dispute resolution, DTSC Interest shall accrue from the date of demand under Paragraph 79 until the date of payment. If

Performing Settling Defendant fails to pay stipulated penalties and DTSC Interest when due, DTSC may institute proceedings to collect the penalties and DTSC Interest, and DTSC is entitled to recovery for attorney's fees and costs for such collection efforts.

82. The payment of penalties and DTSC Interest, if any, shall not alter in any way Performing Settling Defendant's obligation to complete the performance of the Work required under this Consent Decree.

83. Nothing in this Consent Decree shall be construed as prohibiting, altering, or in any way limiting the ability of the United States or DTSC to seek any other remedies or sanctions available by virtue of Performing Settling Defendant's violation of this Consent Decree or of the statutes and regulations upon which it is based, including, but not limited to, penalties pursuant to Section 122(l) of CERCLA, 42 U.S.C. § 9622(*l*), provided, however, that the United States shall not seek civil penalties pursuant to Section 122(*l*) of CERCLA, and DTSC shall not seek civil penalties, for any violation for which a stipulated penalty is provided in this Consent Decree, except in the case of a willful violation of this Consent Decree.

84. Notwithstanding any other provision of this Section, DTSC may, in its unreviewable discretion, waive any portion of stipulated penalties that have accrued pursuant to this Consent Decree.

XXI. COVENANTS BY PLAINTIFFS FOR PERFORMING SETTLING DEFENDANT

85. <u>Covenants for Performing Settling Defendant by the United States</u>. In consideration of the actions that will be performed and the payments that will be made by

Performing Settling Defendant under this Consent Decree, and except as specifically provided in Paragraphs 87, 88 (United States' Pre- and Post-Certification Reservations), and 93 (General Reservations of Rights), the United States covenants not to sue or to take administrative action against Performing Settling Defendant pursuant to Sections 106 and 107(a) of CERCLA and 7003 of RCRA relating to the site. Except with respect to future liability, these covenants shall take effect upon the Effective Date of this Consent Decree. With respect to future liability, these covenants shall take effect upon Certification of Completion of the Remedial Action by DTSC pursuant to Paragraph 50 of Section XIV (Certification of Completion). These covenants are conditioned upon the satisfactory performance by Performing Settling Defendant of its obligations under this Consent Decree. These covenants extend only to Performing Settling Defendant and do not extend to any other person.

86. Covenants for Performing Settling Defendant by DTSC and the California Toxic Substances Control Account. In consideration of the actions that will be performed and the payments that will be made by Performing Settling Defendant under this Consent Decree, and except as specifically provided in Paragraphs 90, 91 (DTSC's Pre- and Post-Certification Reservations), and 93 (General Reservations of Rights), DTSC and the California Toxic Substances Control Account covenant not to sue or to take administrative action against Performing Settling Defendant pursuant to CERCLA, RCRA, and the California Health and Safety Code §§ 25300 *et seq*., to: (1) recover their Response Costs related to the Site; or (2) require Performing Settling Defendant to conduct response actions, including removal or remedial actions in response to the

release or threatened release of hazardous substances at the Site, including the soils and groundwater. Except with respect to future liability, these covenants shall take effect upon the Effective Date of this Consent Decree. With respect to future liability, these covenants shall take effect upon Certification of Completion of the Remedial Action by DTSC pursuant to Paragraph 50 of Section XIV (Certification of Completion). These covenants are conditioned upon the satisfactory performance by Performing Settling Defendant of its obligations under this Consent Decree. These covenants extend only to Performing Settling Defendant and do not extend to any other person.

87. United States' Pre-Certification Reservations. Notwithstanding any other provision of this Consent Decree, the United States reserves, and this Consent Decree is without prejudice to, the right to institute proceedings in this action or in a new action, and/or to issue an administrative order, seeking to compel Performing Settling Defendant to perform further response actions relating to the Site and/or to pay the United States for additional costs of response if, (a) prior to Certification of Completion of the Remedial Action, (1) conditions at the Site, previously unknown to EPA, are discovered, or (2) information, previously unknown to EPA, is received, in whole or in part, and (b) EPA determines that these previously unknown conditions or information together with any other relevant information indicates that the Remedial Action is not protective of human health or the environment.

88. United States' Post-Certification Reservations. Notwithstanding any other provision of this Consent Decree, the United States reserves, and this Consent Decree is without prejudice to, the right to institute proceedings in this action or in a new action,

and/or to issue an administrative order, seeking to compel Performing Settling Defendant to perform further response actions relating to the Site and/or to pay the United States for additional costs of response if, (a) subsequent to Certification of Completion of the Remedial Action, (1) conditions at the Site, previously unknown to EPA, are discovered, or (2) information, previously unknown to EPA, is received, in whole or in part, and (b) EPA determines that these previously unknown conditions or this information together with other relevant information indicate that the Remedial Action is not protective of human health or the environment.

89. For purposes of Paragraph 87 (United States' Pre-Certification Reservations), the information and the conditions known to EPA will include only that information and those conditions known to EPA as of the date Remedial Cost Estimate was approved by DTSC on June 29, 2016, and set forth in Remedial Cost Estimate or the administrative record supporting Remedial Cost Estimate. For purposes of Paragraph 88 (United States' Post-Certification Reservations), the information and the conditions known to EPA shall include only that information and those conditions known to EPA as of the date of Certification of Completion of the Remedial Action, and set forth in Remedial Cost Estimate, the administrative record supporting Remedial Cost Estimate, the post-ROD administrative record, or in any information received by EPA pursuant to the requirements of this Consent Decree prior to Certification of Completion of the Remedial Action.

90. <u>DTSC's Pre-Certification Reservations</u>. Notwithstanding any other provision of this Consent Decree, DTSC reserves, and this Consent Decree is without

prejudice to, the right to institute proceedings in this action or in a new action, and/or to issue an administrative order, seeking to compel Performing Settling Defendant to perform further response actions relating to the Site and/or to pay DTSC for additional costs of response if, (a) prior to Certification of Completion of the Remedial Action, (1) conditions at the Site, previously unknown to DTSC, are discovered, or (2) information, previously unknown to DTSC, is received, in whole or in part, and (b) DTSC determines that these previously unknown conditions or information together with any other relevant information indicates that the Remedial Action is not protective of human health or the environment.

91. DTSC's Post-Certification Reservations. Notwithstanding any other provision of this Consent Decree, DTSC reserves, and this Consent Decree is without prejudice to, the right to institute proceedings in this action or in a new action, and/or to issue an administrative order, seeking to compel Performing Settling Defendant to perform further response actions relating to the Site and/or to pay DTSC for additional costs of response if, (a) subsequent to Certification of Completion of the Remedial Action, (1) conditions at the Site, previously unknown to DTSC, are discovered, or (2) information, previously unknown to DTSC, is received, in whole or in part, and (b) DTSC determines that these previously unknown conditions or this information together with other relevant information indicate that the Remedial Action is not protective of human health or the environment.

92. For purposes of Paragraph 90 (DTSC's Pre-Certification Reservations), the information and the conditions known to DTSC will include only that information

and those conditions known to DTSC as of the date Remedial Cost Estimate was approved by DTSC on June 29, 2016, and set forth in Remedial Cost Estimate or the administrative record supporting Remedial Cost Estimate. For purposes of Paragraph 91 (DTSC's Post-Certification Reservations), the information and the conditions known to DTSC shall include only that information and those conditions known to DTSC as of the date of Certification of Completion of the Remedial Action, and set forth in Remedial Cost Estimate, the administrative record supporting Remedial Cost Estimate, the post-ROD administrative record, or in any information received by DTSC pursuant to the requirements of this Consent Decree prior to Certification of Completion of the Remedial Action.

93. General Reservations of Rights. The Plaintiffs reserve, and this Consent Decree is without prejudice to, all rights against Performing Settling Defendant with respect to all matters not expressly included within Plaintiff's covenants. Notwithstanding any other provision of this Consent Decree, the Plaintiffs reserve all rights against Performing Settling Defendant with respect to:

a. liability for failure by Performing Settling Defendant to meet a requirement of this Consent Decree;

b. liability arising from the past, present, or future disposal, release, or threat of release of Waste Material outside of the Site;

c. liability based on the ownership of the Site by Performing Settling Defendant when such ownership commences after signature of this Consent Decree by Performing Settling Defendant;

d. liability based on the operation of the Site by Performing Settling Defendant when such operation commences after signature of this Consent Decree by Setting Defendant and does not arise solely from Performing Settling Defendant's performance of the Work;

e. liability based on Performing Settling Defendant's transportation, treatment, storage, or disposal, or arrangement for transportation, treatment, storage, or disposal of Waste Material at or in connection with the Site, other than as provided in Remedial Cost Estimate, the Work, or otherwise ordered by DTSC, after signature of this Consent Decree by Performing Settling Defendant;

f. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments;

g. criminal liability;

h. liability for violations of federal or state law that occur during or after implementation of the Work; and

i. liability, prior to Certification of Completion of the Remedial Action, for additional response actions that EPA or DTSC determines are necessary to achieve and maintain Performance Standards or to carry out and maintain the

effectiveness of the remedy set forth in Remedial Cost Estimate, but that cannot be required pursuant to Paragraph 14 (Modification of SOW or Related Work Plans);

94. Work Takeover.

a. In the event DTSC or EPA determines that Performing Settling Defendant has (1) ceased implementation of any portion of the Work, (2) is seriously or repeatedly deficient or late in its performance of the Work, or (3) is implementing the Work in a manner that may cause an endangerment to human health or the environment, DTSC or EPA may issue a written notice ("Work Takeover Notice") to Performing Settling Defendant. Any Work Takeover Notice issued by DTSC or EPA will specify the grounds upon which such notice was issued and will provide Performing Settling Defendant a period of ten days within which to remedy the circumstances giving rise to DTSC's or EPA's issuance of such notice.

b. If, after expiration of the ten-day notice period specified in Paragraph 94.a., Performing Settling Defendant has not remedied to DTSC's or EPA's satisfaction the circumstances giving rise to DTSC's or EPA's issuance of the relevant Work Takeover Notice, DTSC or EPA may at any time thereafter assume the performance of all or any portion(s) of the Work as DTSC or EPA deems necessary ("Work Takeover"). EPA or DTSC will notify Performing Settling Defendant in writing (which writing may be electronic) if EPA or DTSC determines that implementation of a Work Takeover is warranted under this Paragraph 94.b. Funding of Work Takeover costs is addressed under Paragraph 48.

c. Performing Settling Defendant may invoke the dispute resolution procedures set forth in Section XIX to dispute DTSC's or EPA's implementation of a Work Takeover under Paragraph 94.b. However, notwithstanding Performing Settling Defendant's invocation of such dispute resolution procedures, and during the pendency of any such dispute, DTSC or EPA may in its sole discretion commence and continue a Work Takeover under Paragraph 94.b. until the earlier of (1) the date that Performing Settling Defendant remedy, to DTSC's or EPA's satisfaction, the circumstances giving rise to DTSC's or EPA's issuance of the relevant Work Takeover Notice, or (2) the date that a final decision is rendered in accordance with Paragraph 67 (Record Review) requiring EPA to terminate such Work Takeover, or Paragraph 72 (Record Review) requiring DTSC to terminate such Work Takeover.

95. Notwithstanding any other provision of this Consent Decree, the Plaintiffs retain all authority and reserve all rights to take any and all response actions authorized by law.

XXII. COVENANTS BY PLAINTIFFS FOR SETTLING INDIVIDUALS

96. Covenants for Settling Individuals by the United States. In consideration of the actions that will be performed by Performing Settling Defendant under this Consent Decree and by Settling Individuals under Paragraph 114 (Surrender of Site-related Records by Settling Individuals), and except as specifically provided in Paragraph 98 (Reservations of Rights as to Settling Individuals), the United States covenant not to sue or to take administrative action against Settling Individuals pursuant to Sections 106

and 107(a) of CERCLA and Section 7003 of RCRA relating to the Site. This covenant shall take effect upon the Effective Date of this Consent Decree.

97. Covenants for Settling Individuals by DTSC and the California Toxic Substances Control Account. In consideration of the actions that will be performed by Performing Settling Defendant under this Consent Decree and by Settling Individuals under Paragraph 114 (Surrender of Site-related Records by Settling Individuals), and except as specifically provided in Paragraph 98 (Reservations of Rights as to Settling Individuals), DTSC and the California Toxic Substances Control Account covenant not to sue or to take administrative action against Settling Individuals pursuant to CERCLA, RCRA, or the California Hazardous Substances Account ("HSAA"), California Health and Safety Code §§ 25300 *et seq*., to (1) recover Response Costs related to the Site; or (2) require Settling Defendants to conduct response actions, including removal or remedial actions in response to the release or threatened release of hazardous substances at the Site, including the soils and groundwater and California statutory and common law or to seek penalties under the HSAA relating to the Site. This covenant shall take effect upon the Effective Date of this Consent Decree.

98. Reservations of Rights as to Settling Individuals. The Plaintiffs' reserve, and this Consent Decree is without prejudice to, all rights against Settling Individuals with respect to all matters not expressly included within Paragraphs 96 (Covenants for Settling Individuals by the United States) and 97 (Covenants for Settling Individuals by DTSC and the Toxic Substances Control Account). Notwithstanding any other provision

of this Consent Decree, the Plaintiffs' reserve all rights against Settling Individuals with respect to:

a. liability for failure by any Settling Individual to meet a requirement of this Consent Decree;

b. liability arising from the past, present, or future disposal, release, or threat of release of Waste Material outside of the Site;

c. liability based on the ownership of the Site by any Settling Individual when such ownership commences after signature of this Consent Decree by that Settling Individual.

d. liability based on the operation of the Site by any Settling Individual when such operation commences after signature of this Consent Decree by that Settling Individual and does not arise solely from that Settling Individual's performance of the Work;

e. liability based on any Settling Individual's transportation, treatment, storage, or disposal, or arrangement for transportation, treatment, storage, or disposal of Waste Material at or in connection with the Site, other than as provided in the Remedial Cost Estimate, the Work, or otherwise ordered by DTSC, after signature of this Consent Decree by that Settling Individual.

f. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments; and

g. criminal liability.

XXIII. COVENANTS BY PERFORMING SETTLING DEFENDANT AND SETTLING INDIVIDUALS

99. Covenants by Performing Settling Defendant and Settling Individuals. Subject to the reservations in Paragraph 102, Performing Settling Defendant and Settling Individuals covenant not to sue and agree not to assert any claims or causes of action against the United States, DTSC or the California Toxic Substances Account, including but not limited to any direct or indirect claim for reimbursement from the California Hazardous Substances Account or any other State of California fund or account, with respect to the Site and this Consent Decree, including, but not limited to:

a. any direct or indirect claim for reimbursement from the EPA Hazardous Substance Superfund through CERCLA Sections 106(b)(2), 107, 111, 112 or 113, or any other provision of law;

b. any claims under CERCLA Sections 107 or 113, RCRA Section 7002(a), 42 U.S.C. § 6972(a), or state law regarding the Site and this Consent Decree; or

c. any claims arising out of response actions at or in connection with the Site, including any claim under the United States Constitution, the California Constitution, the Tucker Act, 28 U.S.C. §1491, the Equal Access to Justice Act, 28 U.S.C. § 2412, or at common law.

100. Except as provided in Paragraph 110 (Res Judicata and Other Defenses), the covenants in this Section shall not apply to Performing Settling Defendant if the United States , DTSC or the California Toxic Substances Account brings a cause of action or issues an order pursuant to any of the reservations in Section XXI (Covenants

by Plaintiffs for Performing Settling Defendant), other than in Paragraphs 93.a. (claims for failure to meet a requirement of the Consent Decree), 93.g. (criminal liability), and 93.h. (violations of federal/state law during or after implementation of the Work), but only to the extent that Performing Settling Defendant's claims arise from the same response action, response costs, or damages that the United States or DTSC is seeking pursuant to the applicable reservation.

101. Except as provided in Paragraph 110 (Res Judicata and Other Defenses), the covenants in this Section shall not apply to Settling Individuals if the United States, DTSC or the California Toxic Substances Account brings a cause of action or issues an order pursuant to any of the reservations in Section XXII (Covenants by Plaintiffs for Settling Individuals), other than in Paragraphs 98.a. (claims for failure to meet a requirement of the Consent Decree) and 98.g. (criminal liability), but only to the extent that Settling Individuals' claims arise from the same response action, response costs, or damages that the United States or DTSC is seeking pursuant to the applicable reservation.

102. Performing Settling Defendant and Settling Individuals reserve, and this Consent Decree is without prejudice to, claims against the United States, subject to the provisions of Chapter 171 of Title 28 of the United States Code, and brought pursuant to any statute other than CERCLA or RCRA and for which the waiver of sovereign immunity is found in a statute other than CERCLA or RCRA, for money damages for injury or loss of property or personal injury or death caused by the negligent or wrongful act or omission of any employee of the United States, including as the term "United States" is defined in 28 U.S.C. § 2671, while acting within the scope of his or her office

or employment under circumstances where the United States, if a private person, would be liable to the claimant in accordance with the law of the place where the act or omission occurred. However, the foregoing shall not include any claim based on EPA's selection of response actions, or the oversight or approval of Performing Settling Defendant's plans, reports, other deliverables or activities.

103. Nothing in this Consent Decree shall be deemed to constitute preauthorization of a claim within the meaning of Section 111 of CERCLA, 42 U.S.C. § 9611, or 40 C.F.R. § 300.700(d).

104. Claims Against De Micromis Parties. Performing Settling Defendant and Settling Individuals agree not to assert any claims and to waive all claims or causes of action (including but not limited to claims or causes of action under Sections 107(a) and 113 of CERCLA) that they may have for all matters relating to the Site against any person where the person's liability to Performing Settling Defendant or Settling Individuals with respect to the Site is based solely on having arranged for disposal or treatment, or for transport for disposal or treatment, of hazardous substances at the Site, or having accepted for transport for disposal or treatment of hazardous substances at the Site, if all or part of the disposal, treatment, or transport occurred before April 1, 2001, and the total amount of material containing hazardous substances contributed by such person to the Site was less than 110 gallons of liquid materials or 200 pounds of solid materials.

105. The waiver in Paragraph 104 (Claims Against De Micromis Parties) shall not apply with respect to any defense, claim, or cause of action that Performing Settling

Defendant or Settling Individuals may have against any person meeting the criteria in Paragraph 104 if such person asserts a claim or cause of action relating to the Site against Performing Settling Defendant or Settling Individuals. This waiver also shall not apply to any claim or cause of action against any person meeting the criteria in Paragraph 104 if DTSC or EPA determines:

a. that such person has failed to comply with any DTSC or EPA requests for information or administrative subpoenas issued pursuant to California Health and Safety Code sections 25358.1 and/or 25185, or Section 104(e) or 122(e) of CERCLA, 42 U.S.C. § 9604(e) or 9622(e), or Section 3007 of RCRA, 42 U.S.C. § 6927, or has impeded or is impeding, through action or inaction, the performance of a response action or natural resource restoration with respect to the Site, or has been convicted of a criminal violation for the conduct to which this waiver would apply and that conviction has not been vitiated on appeal or otherwise; or

b. that the materials containing hazardous substances contributed to the Site by such person have contributed significantly, or could contribute significantly, either individually or in the aggregate, to the cost of response action or natural resource restoration at the Site.

XXIV. EFFECT OF SETTLEMENT; CONTRIBUTION

106. Except as provided in Paragraph 104 (Claims Against De Micromis Parties), nothing in this Consent Decree shall be construed to create any rights in, or grant any cause of action to, any person not a Party to this Consent Decree. Each of the Parties expressly reserves any and all rights (including, but not limited to, pursuant to Section

113 of CERCLA, 42 U.S.C. § 9613), defenses, claims, demands, and causes of action that each Party may have with respect to any matter, transaction, or occurrence relating in any way to the Site against any person not a Party hereto. Nothing in this Consent Decree diminishes the right of the Plaintiffs, pursuant to Section 113(f)(2) and (3) of CERCLA, 42 U.S.C. § 9613(f)(2)-(3), to pursue any such persons to obtain additional response costs or response action and to enter into settlements that give rise to contribution protection pursuant to Section 113(f)(2).

107. The Parties agree, and by entering this Consent Decree this Court finds, that this Consent Decree constitutes a judicially approved settlement for purposes of Section 113(f)(2) of CERCLA, 42 U.S.C. § 9613(f)(2), and that Performing Settling Defendant and each Settling Individual is entitled, as of the Effective Date, to protection from contribution actions or claims as provided by Section 113(f)(2) of CERCLA, or as may be otherwise provided by law, for "matters addressed" in this Consent Decree. The "matters addressed" in this Consent Decree are all response actions taken or to be taken and all response costs incurred or to be incurred, at or in connection with the Site, by the United States, the California Toxic Substances Control Account, DTSC, the California Hazardous Substances Account, or any other person provided, however, that if the United States, the California Toxic Substances Control Account or DTSC exercises rights under the reservations in Section XXI (Covenants by Plaintiffs for Performing Settling Defendant) or Section XXII (Covenants by Plaintiffs for Settling Individuals), other than in Paragraphs 93.a. or 98.a. (claims for failure to meet a requirement of the Consent Decree), 93.g. or 98.g. (criminal liability), or 93.h. (violations of federal/state law during

or after implementation of the Work), the "matters addressed" in this Consent Decree will no longer include those response costs or response actions.

108. If Performing Settling Defendant or any Settling Individual intends to bring any suit or claim for matters related to this Consent Decree, Performing Settling Defendant or such Settling Individual shall notify the Plaintiffs in writing no later than 60 days prior to the initiation of such suit or claim.

109. If Performing Settling Defendant or any Settling Individual has a suit or claim brought against him/her/it for matters related to this Consent Decree, Performing Settling Defendant or such Settling Individual shall notify the Plaintiffs in writing within ten days after service of the complaint on Performing Settling Defendant or such Settling Individual. In addition, Performing Settling Defendant or such Settling Individual shall notify the Plaintiffs within ten days after service or receipt of any Motion for Summary Judgment and within ten days after receipt of any order from a court setting a case for trial in any suit brought against the Performing Settling Defendant or such Settling Individual for matters related to this Consent Decree.

110. Res Judicata and Other Defenses. In any subsequent administrative or judicial proceeding initiated by the United States, DTSC or the California Toxic Substances Account for injunctive relief, recovery of response costs, or other appropriate relief relating to the Site, Performing Settling Defendant and Settling Individuals shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, res judicata, collateral estoppel, issue preclusion, claim-splitting, or other defenses based upon any contention that the claims raised by the United States, DTSC or

the California Toxic Substances Account in the subsequent proceeding were or should have been brought in the instant case; provided, however, that nothing in this Paragraph affects the enforceability of the covenants not to sue set forth in Sections XXI (Covenants by Plaintiffs for Performing Settling Defendant) and XXII (Covenants by Plaintiffs for Settling Individuals).

XXV. ACCESS TO INFORMATION

111. Performing Settling Defendant shall provide to EPA and DTSC, upon request, copies of all records, reports, documents, and other information (including records, reports, documents, and other information in electronic form) (hereinafter referred to as "Records") within its possession or control or that of its contractors or agents relating to activities at the Site or to the implementation of this Consent Decree, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence, or other documents or information regarding the Work. Performing Settling Defendant shall also make available to EPA and DTSC, for purposes of investigation, information gathering, or testimony, its employees, agents, or representatives with knowledge of relevant facts concerning the performance of the Work.

112. Business Confidential and Privileged Documents.

a. Performing Settling Defendant may assert business confidentiality claims covering part or all of the Records submitted to Plaintiffs under this Consent Decree to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. § 9604(e)(7), and 40 C.F.R. § 2.203(b). Records determined to be confidential

by EPA will be afforded the protection specified in 40 C.F.R. Part 2, Subpart B. If no claim of confidentiality accompanies Records when they are submitted to EPA and DTSC, or if EPA has notified Performing Settling Defendant that the Records are not confidential under the standards of Section 104(e)(7) of CERCLA or 40 C.F.R. Part 2, Subpart B, the public may be given access to such Records without further notice to Performing Settling Defendant. With respect to documents submitted by the Performing Settling Defendant to DTSC under this Consent Decree, Performing Settling Defendant may assert trade secret claims or other claims of privilege or confidentiality under the California Uniform Trade Secrets Act ("UTSA"), Cal. Civil Code § 3426, *et seq.*, or the California Public Records Act ("PRA"), Cal. Gov't Code § 6254 *et seq.,* covering all or part of such documents. In the event of a third-party request for production of such documents, DTSC shall, to the extent required by law, determine whether those documents or portions thereof are subject to a claim of confidentiality or other privilege under the PRA or the UTSA by Performing Settling Defendant. DTSC shall provide any legally-required notice to Performing Settling Defendant that a request for documents claimed confidential or privileged by Performing Settling Defendant has been made. Performing Settling Defendant shall bear the responsibility to justify its asserted privileges or confidentiality claims for the documents requested and to seek judicial relief from disclosure.

b. Performing Settling Defendant may assert that certain Records are privileged under the attorney-client privilege or any other privilege recognized by federal law. If Performing Settling Defendant assert such a privilege in lieu of providing

Records, it shall provide Plaintiffs with the following: (1) the title of the Record; (2) the date of the Record; (3) the name, title, affiliation (e.g., company or firm), and address of the author of the Record; (4) the name and title of each addressee and recipient; (5) a description of the contents of the Record; and (6) the privilege asserted by Performing Settling Defendant. If a claim of privilege applies only to a portion of a Record, the Record shall be provided to the Plaintiffs in redacted form to mask the privileged portion only. Performing Settling Defendant shall retain all Records that it claims to be privileged until the Plaintiffs have had a reasonable opportunity to dispute the privilege claim and any such dispute has been resolved in Performing Settling Defendant's favor.

c. No Records created or generated pursuant to the requirements of this Consent Decree shall be withheld from the Plaintiffs on the grounds that they are privileged or confidential.

113. No claim of confidentiality or privilege shall be made with respect to any data, including, but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, or engineering data, or any other documents or information evidencing conditions at or around the Site.

XXVI. RETENTION OF RECORDS

114. <u>Surrender of Site-Related Records by Settling Individuals</u>. Within 180 days of the Effective Date, each Settling Individual shall make a reasonable effort to locate Records relating to the Site that are within that Settling Individual's possession or control, and shall provide either originals or legible copies of any such Records to Performing Settling Defendant by mailing or otherwise delivering them to the following

address: Attn. Mark Underwood, EnviroAnalytics Group LLC, 1650 Des Peres Road, Suite 303, St. Louis, MO 63131.

115. Until ten years after Performing Settling Defendant's receipt of DTSC's notification pursuant to Paragraph 51 (Completion of the Work), Performing Settling Defendant shall preserve and retain all non-identical copies of Records (including Records in electronic form) now in its possession or control or that come into its possession or control that relate in any manner to its liability under CERCLA with respect to the Site, and all Records that relate to the liability of any other person under CERCLA with respect to the Site. Performing Settling Defendant must also retain, and instruct its contractors and agents to preserve, for the same period of time specified above all non-identical copies of the last draft or final version of any Records (including Records in electronic form) now in its possession or control or that come into its possession or control that relate in any manner to the performance of the Work, provided, however, that Performing Settling Defendant (and its contractors and agents) must retain, in addition, copies of all data generated during the performance of the Work and not contained in the aforementioned Records required to be retained. Each of the above record retention requirements shall apply regardless of any corporate retention policy to the contrary. Performing Settling Defendant shall also retain all non-identical copies of Records relating to the Site provided to it by Settling Individuals, including but not limited to Records provided pursuant to Paragraph 114 (Surrender of Site-Related Records by Settling Individuals).

116. At the conclusion of this record retention period, Performing Settling Defendant shall notify Plaintiffs at least 90 days prior to the destruction of any such Records, and, upon request by Plaintiffs, Performing Settling Defendant shall deliver any such Records to DTSC or EPA. Performing Settling Defendant may assert that certain Records are privileged under the attorney-client privilege or any other privilege recognized by federal law. If Performing Settling Defendant asserts such a privilege, it shall provide Plaintiffs with the following: (a) the title of the Record; (b) the date of the Record; (c) the name, title, affiliation (e.g., company or firm), and address of the author of the Record; (d) the name and title of each addressee and recipient; (e) a description of the subject of the Record; and (f) the privilege asserted by Performing Settling Defendant. If a claim of privilege applies only to a portion of a Record, the Record shall be provided to Plaintiffs in redacted form to mask the privileged portion only. Performing Settling Defendant shall retain all Records that it claims to be privileged until the Plaintiffs have had a reasonable opportunity to dispute the privilege claim and any such dispute has been resolved in Performing Settling Defendant's favor. However, no Records created or generated pursuant to the requirements of this Consent Decree shall be withheld on the grounds that they are privileged or confidential.

117. Performing Settling Defendant certifies that, to the best of its knowledge and belief, after thorough inquiry, it has not altered, mutilated, discarded, destroyed, or otherwise disposed of any Records (other than identical copies) relating to its potential liability regarding the Site since the earlier of notification of potential liability by the United States or DTSC or the filing of suit against it regarding the Site and that it has

fully complied with any and all EPA and DTSC requests for information regarding the Site pursuant to Sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e), and Section 3007 of RCRA, 42 U.S.C. § 6927, and state law.

XXVII. NOTICES AND SUBMISSIONS

118. Whenever, under the terms of this Consent Decree, written notice is required to be given or a report or other document is required to be sent by one Party to another, it shall be directed to the individuals at the addresses specified below, unless those individuals or their successors give written notice of a change to the other Parties in writing. All notices and submissions shall be considered effective upon receipt, unless otherwise provided. Written notice as specified in this Section shall constitute complete satisfaction of any written notice requirement of the Consent Decree with respect to the Plaintiffs and Performing Settling Defendant, respectively. Notices required to be sent to EPA, and not to the United States, under the terms of this Consent Decree should not be sent to the U.S. Department of Justice. The Parties contemplate that the notices and submissions required under this Consent Decree will generally not affect the obligations of or the protections afforded to Settling Individuals and therefore need not be provided to Settling Individuals.

As to the United States:	Chief, Environmental Enforcement Section Environment and Natural Resources Division U.S. Department of Justice P.O. Box 7611 Washington, D.C. 20044-7611 Re: DJ # 90-11-3-835/2
As to EPA:	Director, Superfund Division United States Environmental Protection Agency

	Region IX 75 Hawthorne Street San Francisco, CA 94105
and:	
	Anhtu Nguyen EPA Project Coordinator United States Environmental Protection Agency Region IX 75 Hawthorne Street San Francisco, CA 94105
As to the Regional Financial Management Officer:	Regional Financial Management Officer 75 Hawthorne Street San Francisco, CA 94105
As to DTSC and the California Toxic Substances Control Act:	Janet Naito, Branch Chief Brownfields and Environmental Restoration Program California Department of Toxic Substances Control 700 Heinz Avenue Berkeley, CA 94710-2721
	Lynn Goldman Office of Legal Counsel California Department of Toxic Substances Control 1001 I Street, 23rd Floor P.O. Box 806 Sacramento, CA 95812-0806
As to Performing Settling Defendant:	Thomas G. Pike, Esq. Performing Settling Defendant's Project Coordinator Commercial Development Co. Environmental Liability Transfer, Inc. EnvironAnalytics Group, LLC 1650 Des Peres Rd. – Suite 330 Saint Louis, MO 63131 tpike@cdcco.com

XXVIII. RETENTION OF JURISDICTION

119. This Court retains jurisdiction over both the subject matter of this Consent Decree and Performing Settling Defendant for the duration of the performance of the

terms and provisions of this Consent Decree for the purpose of enabling any of the Parties to apply to the Court at any time for such further order, direction, and relief as may be necessary or appropriate for the construction or modification of this Consent Decree, or to effectuate or enforce compliance with its terms, or to resolve disputes in accordance with Section XIX (Dispute Resolution).

XXIX. APPENDICES

120. The following appendices are attached to and incorporated into this Consent Decree:

"Appendix A" is the Fourth Amendment to the Custodian Fund Agreement.

"Appendix B" is the Land Use Covenant.

"Appendix C" is the 1994 AOC.

"Appendix D" is the Record of Decision ("ROD").

"Appendix E" is the RAP including the RAP Amendment and ESD.

"Appendix F" is the Remedial Cost Estimate.

"Appendix G" is the Site Map.

"Appendix H" is the Statement of Work ("SOW").

"Appendix I" is the Performance Guarantee Trust.

"Appendix J" is the Community Relations Plan

XXX. COMMUNITY INVOLVEMENT

121. If requested by DTSC, after consultation with EPA, Performing Settling Defendant shall participate in community involvement activities pursuant to the Community Relations Plan developed by DTSC, as may be revised and updated to comply with state law. The May 12, 1999 revision to the Community Relations Plan is attached as Appendix J. Performing Settling Defendant shall also cooperate with DTSC and EPA in providing information regarding the Work to the public. As requested by DTSC, after consultation with EPA, Performing Settling Defendant shall participate in the preparation of such information for dissemination to the public and in public meetings that may be held or sponsored by DTSC or EPA to explain activities at or relating to the Site. Costs incurred by the United States under this Section, including the costs of any technical assistance grant under Section 117(e) of CERCLA, 42 U.S.C. § 9617(e), shall be considered Future Response Costs that Performing Settling Defendant shall pay pursuant to Section XVI (Payments for Response Costs). Costs incurred by DTSC under this Section shall be considered DTSC Future Response Costs that Performing Settling Defendant shall pay pursuant to Section XVI (Payments for Response Costs).

XXXI. MODIFICATION

122. Except as provided in Paragraph 14 (Modification of SOW or Related Work Plans), material modifications to this Consent Decree, including the SOW, shall be in writing, signed by the United States, DTSC, and Performing Settling Defendant, and shall be effective upon approval by the Court. Except as provided in Paragraph 14, non-material modifications to this Consent Decree, including the SOW, shall be in writing and shall be effective when signed by duly authorized representatives of the United

States, DTSC, and Performing Settling Defendant. A modification to the SOW shall be considered material if it fundamentally alters the basic features of the selected remedy within the meaning of 40 C.F.R. § 300.435(c)(2)(ii).

123. Modifications (non-material or material) pursuant to Paragraph 122 that affect the obligations of or the protections afforded to Settling Individuals must be executed by Settling Individuals, in addition to Plaintiffs and Performing Settling Defendant. Modifications (non-material or material) that do not affect the obligations of or the protections afforded to Settling Individuals shall not require the signatures of Settling Individuals.

124. Nothing in this Consent Decree shall be deemed to alter the Court's power to enforce, supervise, or approve modifications to this Consent Decree.

XXXII. LODGING AND OPPORTUNITY FOR PUBLIC COMMENT

125. This Consent Decree shall be lodged with the Court for a period of not less than 30 days for public notice and comment in accordance with Section 122(d)(2) of CERCLA, 42 U.S.C. § 9622(d)(2), and 28 C.F.R. § 50.7. The Plaintiffs each reserve the right to withdraw or withhold their consent if the comments regarding the Consent Decree disclose facts or considerations that indicate that the Consent Decree is inappropriate, improper, or inadequate. Performing Settling Defendant and Settling Individuals consent to the entry of this Consent Decree without further notice.

126. If for any reason the Court should decline to approve this Consent Decree in the form presented, this agreement is voidable at the sole discretion of any Party and

the terms of the agreement may not be used as evidence in any litigation between the Parties.

XXXIII. SIGNATORIES/SERVICE

127. Each undersigned representative of Performing Settling Defendant, Settling Individuals, the Assistant Attorney General for the Environment and Natural Resources Division of the Department of Justice, the State of California Attorney General's Office, DTSC and the California Toxic Substances Control Account certifies that he or she is fully authorized to enter into the terms and conditions of this Consent Decree and to execute and legally bind such Party to this document.

128. Performing Settling Defendant and Settling Individuals agree not to oppose entry of this Consent Decree by this Court or to challenge any provision of this Consent Decree unless the United States or DTSC has notified Performing Settling Defendant and Settling Individuals in writing that it no longer supports entry of the Consent Decree.

129. Performing Settling Defendant and Settling Individuals shall identify, on the attached signature page, the name, address, and telephone number of an agent who is authorized to accept service of process by mail on behalf of that Party with respect to all matters arising under or relating to this Consent Decree. Performing Settling Defendant and Settling Individuals agree to accept service in that manner and to waive the formal service requirements set forth in Rule 4 of the Federal Rules of Civil Procedure and any applicable local rules of this Court, including, but not limited to, service of a summons.

Performing Settling Defendant need not file an answer to the complaint in this action unless or until the Court expressly declines to enter this Consent Decree.

XXXIV. FINAL JUDGMENT

130. This Consent Decree and its appendices constitute the final, complete, and exclusive agreement and understanding among the Parties regarding the settlement embodied in the Consent Decree. The Parties acknowledge that there are no representations, agreements, or understandings relating to the settlement other than those expressly contained in this Consent Decree.

131. Upon entry of this Consent Decree by the Court, this Consent Decree shall constitute a final judgment between and among the Plaintiffs, Performing Settling Defendant and Settling Individuals. The Court enters this judgment as a final judgment under Fed. R. Civ. P. 54 and 58.

SO ORDERED THIS 1ST DAY OF March, 2018.

United States District Judge

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR THE UNITED STATES OF AMERICA:

12/19/17
Date

ELLEN M. MAHAN
Deputy Section Chief
Environmental Enforcement Section
Environment and Natural Resources Division
United States Department of Justice
Washington, D.C. 20530

DAVIS H. FORSYTHE
Trial Attorney
Environmental Enforcement Section
Environment & Natural Resources Division
United States Department of Justice
999 18th Street
South Terrace – Suite 370
Denver, CO 80202

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR THE UNITED STATES OF AMERICA (CONT.):

12/5/17

ENRIQUE MANZANILLA
Superfund Division Director, Region IX
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105

11/22/17

SARA GOLDSMITH
Assistant Regional Counsel
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, CA 94105

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR THE CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL AND THE TOXIC SUBSTANCES CONTROL ACCOUNT:

11/20/2017
Date

Janet Naito, Branch Chief
Brownfields and Environmental Restoration Program
California Department of Toxic Substances Control
700 Heinz Avenue
Berkeley, CA 94710-2721

APPROVED AS TO FORM.

XAVIER BECERRA
Attorney General of California

MARGARITA PADILLA
Supervising Deputy Attorney General

11/15/17
Date

DENNIS L. BECK, JR.
Deputy Attorney General

Attorneys for Plaintiff People of the State of California, ex. rel. Department of Toxic Substances

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR PERFORMING SETTLING DEFENDANT COAST WOOD PRESERVING, INC.:

Nov. 1, 2017
Date

Joyce Logsdon

Name (print): Joyce Logsdon
Title: President
Address: P.O Box 740
Turlock, CA 95381

Agent Authorized to Accept Service on Behalf of Above-signed Party:

Name (print): Ron Hillberg
Title: Attorney at Law
Address: 630 Crane Ave., Suite C. Turlock, CA 95380
Phone: (209) 667-0761
email: ron@hillberglaw.biz

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR SETTLING INDIVIDUAL
JOYCE LOGSDON, Trustee of the MICHAEL LOGSDON WOOD TRUST

Nov. 1, 2017
Date

Joyce Logsdon
Name (print): Joyce Logsdon
Title: Trustee
Address: P.O. Box 740
Turlock, CA 95381

Agent Authorized to Accept Service on Behalf of Settling Individuals:

Name (print): Ron Hillberg
Title: Attorney At Law
Address: 630 Crane Ave., Suite C. Turlock, CA 95380
Phone (209) 667-0761
email: ron@hillberglaw.biz

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR SETTLING INDIVIDUAL
JOYCE LOGSDON, Trustee of the SCHMIDT WOOD TRUST:

Nov. 1, 2017
Date

Joyce Logsdon
Name (print): Joyce Logsdon
Title: Trustee
Address: P.O. Box 740
Turlock, CA 95381

Agent Authorized to Accept Service on Behalf of Settling Individuals:

Name (print): Ron Hillberg
Title: Attorney A Law
Address: 630 Crane Ave., Suite C. Turlock, CA 95380
Phone: (209) 667-0761
email: ron@hillberglaw.biz

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR SETTLING INDIVIDUAL JOYCE LOGSDON:

Nov. 1, 2017
Date

Joyce Logsdon
Name (print): Joyce Logsdon
Title:
Address: P.O Box 740
Turlock, CA 95381

Agent Authorized to Accept Service on Behalf of Settling Individuals:

Name (print): Ron Hillberg
Title: Attorney At Law
Address: 630 Crane Ave. Suite C Turlock, CA 95380
Phone: (209) 667-0761
email: ron@hillberglaw.biz

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR SETTLING INDIVIDUAL
EUGENE E. PIETILA:

10-31-17
Date

Eugene E. Pietila
Name (print): Eugene E Pietila
Title: manager
Address: P.O. Box 369
Hopland, Ca 95449

Agent Authorized to Accept Service on Behalf of Settling Individuals:

Name (print): Ron Hillberg
Title: Attorney At Law
Address: 630 Crane Ave. Suite C Turlock, CA 95380
Phone: (209)667-0761
email: ron@hillberglaw.biz

Signature Page for Consent Decree regarding the Coast Wood Preserving, Inc. Superfund Site

FOR SETTLING INDIVIDUAL ROBERT SCHMIDT:

11.1.17
Date

Robert Schmidt

Name (print): Robert Schmidt
Title: Project Coordinator
Address: P.O. Box 740
Turlock, CA 95381

Agent Authorized to Accept Service on Behalf of Settling Individuals:

Name (print): Ron Hillberg
Title: Attorney At Law
Address: 630 Crane Ave., Suite C Turlock, CA 95380
Phone: (209) 667-0761
email: ron@hillberglaw.biz

APPENDIX A

Fourth Amendment to Custodian Fund Agreement

FOURTH AMENDMENT TO CUSTODIAN FUND AGREEMENT

THIS FOURTH AMENDMENT TO THE CUSTODIAN FUND AGREEMENT ("Fourth Amendment") is effective as of 31th day of December, 2017, between COAST WOOD PRESERVING, INC. ("Respondent"), and DUETSCHE BANK TRUST COMPANY AMERICAS as custodian ("Custodian").

WHEREAS, the Custodian Fund Agreement was entered into in July 1995 between Respondent and Bankers Trust Company ("Agreement") and under the provisions of the Agreement Duetsche Bank Trust Company Americas has replaced Bankers Trust Company as the custodian.

WHEREAS, a First Amendment of the Agreement was entered into on June 30, 2016 extending the termination date of the Agreement, a Second Amendment of the Agreement was entered into on January 31, 2017 extending the termination date of the Agreement and a Third Amendment of the Agreement was entered into on June 30, 2017 also extending the termination date of the Agreement.

WHEREAS, the Agreement is acknowledged by Respondent and Custodian as an element of a resolution of a dispute between Respondent and, collectively, the State of California and United States with respect to the Coast Wood Preserving, Inc. facility in Ukiah, California ("Site").

WHEREAS, the Agreement, as amended by the Third Amendment, is scheduled to terminate on December 31, 2017, and the Respondent, the State of California and United States are in agreement that the term of Agreement should be extended to and including July 31, 2018 to allow them to enter into a new agreement that would amend and extend the existence of a trust fund to pay for future response costs expected to be incurred during the performance of certain work at the Site.

WHEREAS, Respondent and Custodian are in agreement that the term of the Agreement should be extended to and including July 31, 2018.

NOW, THEREFORE, the Custodian hereby agrees to amend the Agreement as follows:

1. Notwithstanding any other provision of the Agreement, the Agreement shall remain in full force and affect to and including July 31, 2018. All other provisions of the Agreement remain the same and are not affected by this [redacted] Amendment.

WITNESSES

COAST WOOD PRESERVING, INC.

By: Joyce Logsdon

Its: PRESIDENT

DUETSCHE BANK TRUST COMPANY AMERICAS

By:

Its: Olga Belenkaya
Assistant Vice President

Andrea E. Gilardi
Assistant Vice President

APPENDIX B

Land Use Covenant

22170

RECORDED AT REQUEST OF

BOOK 1792 PAGE 564

NOV 29 2 56 PM '89

OFFICIAL RECORDS
MENDOCINO COUNTY CALIF
MARSHA A. YOUNG
RECORDER

COAST WOOD PRESERVING, INC.

UKIAH, CALIFORNIA

TOXIC SUBSTANCES CONTROL DIVISION
12-122
DEC 20 1989
MR
CALIFORNIA DEPARTMENT OF HEALTH SERVICES
RECEIVED

45.00

Recording Requested by:
Coast Wood Preserving, Inc.

When Recorded, Mail to:

Department of Health Services
Toxic Substances Control Division
Region 2
2151 Berkeley Way, Annex 7
Berkeley, California 94704
Attention: Howard K. Hatayama, Chief

COVENANT AND AGREEMENT

This Covenant and Agreement ("Covenant") is made as of the 25 th day of September, 1989 by Coast Wood Preserving, Inc., a California Corporation, ("Covenantor") who is the owner of record of certain Property situated in Ukiah, State of California, described in Exhibit A, attached hereto and incorporated herein by this reference ("the Property") and by the California Department of Health Services, with reference to the following facts:

A. This Property has contained and currently contains hazardous waste.

B. This Property is the site of a wood preserving plant using chromated copper arsenate. In the process of using this

preservative some of the preservative has been released into the soil on-site. Various governmental agencies have overseen the investigation of the site and currently oversee activities conducted at the site.

Pursuant to Section 25355.5(a)(1)(B) of the Health and Safety Code, the Department issued a Remedial Action Order Docket No. HSA 88/89-015 on December 16, 1988 to require Coast Wood Preserving, Inc. to implement a Remedial Action Plan (RAP).

The RAP requires continued extraction and treatment of contaminated groundwater, and complete remediation of contaminated soil upon closure of the Property.

C. Contamination at the Property

1. Chromated copper arsenate is a wood preserving compound. Over the years of operation, the cumulative drippings or spillage of the chemical solution has resulted in soil and groundwater contamination.

2. Soil underlying the Property has been contaminated with chromium, arsenic and copper. Arsenic has been found in soils in concentrations as high as 220 parts per million (ppm), chromium in concentrations as high as 540 ppm and copper in concentrations as high as 230

ppm. Generally, concentrations are highest near the retort and sump areas.

3. Groundwater underlying and adjacent to the Property is contaminated with chromium (VI) and total chromium. Chromium (VI) and total chromium have been found in concentrations as high as 78 ppm.

D. Health Effects

ARSENIC (As)

The principal uses of arsenic and arsenic compounds are in pesticides, cotton desicants, textiles, glass, alloys and in the manufacture of integrated circuits. Arsenic is well absorbed via the oral, dermal and inhalation routes. Acute ingestion of a high dose of arsenic leads to a burning sensation in the mouth, nausea and vomiting. This is followed by muscular twitches, liver, kidney and heart dysfunctions and by delirium, coma and death. Chronic exposure to arsenic is associated with a persistent metallic taste in the mouth, hyperkeratosis, anemia and peripheral nerve disease. Chronic exposure to arsenic has also been shown to increase the risk of developing skin cancer, aplastic anemia and leukemia.

CHROMIUM (Cr)

Chromium is used in the metal, chemical, tanning, and paint industries. Chromium has two biologically important oxidation states, the trivalent (III) and hexavalent (VI) forms. Chromium (III) is a nutritionally essential trace metal thought to play a role in the metabolism of insulin and the regulation of blood glucose. Chromium (VI) is a corrosive and ulcerogenic agent. Chronic inhalation of chromium (VI) compounds have been associated with the development of lung disease including cancer in humans.

COPPER (Cu)

Copper is a nutritionally essential trace element. It is used extensively in a wide variety of industrial processes and salts of copper are also used as algicides and fungicides. Copper is well-adsorbed by the oral route. Acute inhalation of copper fumes or dust can result in a reversible influenza-like syndrome. Chronic ingestion of high levels of copper has been reported to cause hemolysis, fibrosis and cirrhosis of the liver, nervous system damage and kidney dysfunction.

E. Routes of Exposure and Population at Risk

There are several water wells within a one-mile radius of the Property. The Russian River is downgradient about half

a mile from the Property. Water wells and the Russian River are the primary water supply sources for the Ukiah region.

Chromium, arsenic and copper present in surface soil may be dispersed and become airborne if the asphalt pavement is not properly maintained. Potential routes of human exposure resulting from wind blown dust are inhalation or ingestion of contaminated particles in the air.

F. Covenantor desires and intends that in order to protect the present or future public health and safety, the Property shall be used in such a manner as to avoid potential harm to persons or Property which may result from hazardous wastes which have been deposited on the Property.

ARTICLE I

GENERAL PROVISIONS

1.01 Provisions to Run with the Land. This Covenant sets forth protective provisions, covenants, restrictions and conditions (collectively referred to as "Restrictions"), upon and subject to which the Property and every portion thereof shall be improved, held, used, occupied, leased, sold, hypothecated, encumbered, and/or conveyed. Each and all of the Restrictions shall run with the land, and pass with each and every portion, the Property, and shall apply to and bind the respective

successors in interest thereof. Each and all of the Restrictions are imposed upon the entire Property unless expressly stated as applicable to a specific portion of the Property. Each and all of the Restrictions are imposed pursuant to Section 25222.1 of the Health and Safety Code and run with the land pursuant to Section 25230(a)(1) of the Health and Safety Code. Each and all of the Restrictions are for the benefit of and enforceable by the Department.

1.02 Concurrence of Owners Presumed. All purchasers, lessees, or possessors of any portion of the Property shall be deemed by their purchase, leasing, or possession of such Property to be in accord with the foregoing and to agree for and among themselves, their heirs, successors, and assignees, and the agents, employees, and lessees of such owners, heirs, successors, and assignees that the Restrictions as herein established must be adhered to for the benefit of future Owners and Occupants and that their interest in the Property shall be subject to the Restrictions contained herein.

1.03 Incorporation into Deeds and Leases. Covenantor desires and convenants that the Restrictions set out herein shall be incorporated in, and this Covenant and Agreement shall be attached to, each and all deeds and leases of any portion of the Property.

ARTICLE II

DEFINITIONS

2.01 Department. "Department" shall mean the California State Department of Health Services and shall include its successor agencies, if any.

2.02 Improvements. "Improvements" shall mean all buildings, roads, driveways, and paved parking areas, constructed or placed upon any portion of the Property.

2.03 Occupants. "Occupants" shall mean Owners and those persons entitled by ownership, leasehold, or other legal relationship to the exclusive right to occupy any portion of the Property.

2.04 Owner. "Owner" shall mean the Covenantor or its successors in interest, including heirs and assigns, who hold title to all or any portion of the Property.

2.05 Director. "Director" shall mean the Director of the California Department of Health Services, or his or her designee.

ARTICLE III

DEVELOPMENT, USE AND CONVEYANCE OF THE PROPERTY

3.01 Restrictions on Use. Covenantor promises to restrict the use of the Property, as described in Exhibit A, as follows:

(1) No owner or occupant of the Property shall act in any manner that will aggravate or contribute to the existing contamination at the Property or interfere with the implementation of any remedial action at the Property.

(2) All owners and occupants of the Property or any portion thereof shall maintain an asphalt or concrete cap over the Property until such time as the soil remediation has begun in accordance with the approved RAP and Remedial Design (RD).

(3) In the event of any proposed earth movement or excavation by Owner or Occupant upon the Property, or any portion thereof, the Owner or Occupant of said Property shall notify and receive approval from the Director of such proposed activity 30 days prior to the beginning of such earth movement or excavation activities and shall:

(A) Comply with any applicable requirements of the California Occupational Health and Safety Agency, the Mendocino County Air Pollution Control District, the North Coast Regional Water Quality Control Board, the

United States Environmental Protection Agency, and the Department of Health Services;

(B) Utilize appropriate procedures to control dust during the period of earth movement or excavation;

(C) Handle all materials excavated on the premises as hazardous wastes unless shown otherwise by sampling and testing pursuant to the hazardous waste criteria set forth in Division 4, Chapter 30, Title 22, California Code of Regulations; and

(D) Protect any stockpiled hazardous waste from wind, rain, and any other condition which may cause the dispersal of any such hazardous waste.

In the event of an emergency any owner or occupant of the Property within twenty-four (24) hours of such an emergency may request permission from the Department by telephone for any proposed earth movement or excavation. The Department shall either approve or deny any such request within one business working day of receipt of such a request. A written report shall be submitted within five days of the Department's approval. The report shall include a description of emergency and its cause, period of time the proposed activity, and steps taken to eliminate the emergency.

(4) No owner or occupant of the Property shall disturb the interim asphalt and concrete cover, slurry wall, the function of any portion of the groundwater extraction and treatment system or monitoring system, or surface water run-off control other than routine maintenance in accordance with approved RAP and RD.

(5) Any or all wastes must be managed in accordance with all applicable requirements.

(6) No production wells shall be drilled without the express prior written approval of the Director and any other agency with jurisdiction. Monitoring or other test wells are not subject to this provision.

(7) Without the express prior written approval of the Director no construction or placement of a building or structure shall occur on the Property which is intended for use as any of the following, nor shall any new use of an existing structure or building on the premises occur as any of the following:

(A) A hospital;

(B) A school for persons under 21 years of age;

(C) A day-care center;

(D) Any permanently occupied human habitation other than those used for industrial purposes.

3.02 Conveyance of Property. Any prospective purchaser, lessee, or assignee of the Property or of an interest in the Property must demonstrate to the satisfaction of the Department that said purchaser, lessee or assignee of the Property is financially capable of implementing the selected remedial action for the Property. The Owner or Owners shall provide thirty (30) days advance notice to the Department of any sale, lease, or other conveyance of the Property or an interest in the Property to a third person. The Owner(s) shall provide information of intended use for the Property by subsequent owner to the extent the existing owner(s) have such information.

3.03 Enforcement. Failure of the Owner to comply with any of the requirements, as set forth in paragraph 3.01 above, shall be grounds for the Department, by reason of the Covenant, to require that the Owner or Occupants modify or remove any Improvements constructed in violation of the paragraph. This Covenant shall be enforceable by the Department pursuant to Section 25236 of the Health and Safety Code.

3.04 Notice in Agreement. All Owners and Occupants shall execute a written instrument which shall accompany all purchase, lease, sublease, or rental agreements relating to the Property. The instrument shall contain the following statement:

> The land described herein contains hazardous waste. Such condition renders the land and the owner, lessee, or other

possessor of the land subject to requirements, restrictions, provisions, and liabilities contained in Chapter 6.5 (commencing with Section 25100) of Division 20 of the Health and Safety Code. This statement is not a declaration that a hazard exists.

3.05 Disclaimer. The State of California makes no representations as the suitability of the Property for any particular purpose.

ARTICLE IV
VARIANCE AND TERMINATION

4.01 Variance. Any Owner or, with the Owner's consent, any Occupant of the Property or any portion thereof may apply to the Department for a written variance from the provisions of this Covenant. Such application shall contain 1) a statement of who is applying for the variance; 2) the proposed variance; and 3) a statement of reasons in support of the granting of the variance. In addition, the owner shall demonstrate to the satisfaction of the Department that the proposed variance will not cause or allow any of the following effects associates with hazardous waste or extremely hazardous waste:

A. The creation or increase of significant present or future hazards to the public.

B. Any significant diminution of the ability to mitigate any significant potential or actual hazard to public health.

C. Any long-term increase in the number of humans or animals exposed to significant hazards which affect the health, well-being, or safety of the public.

Upon making a decision to approve or deny the proposed variance, the Director shall issue and cause to be served the decision and findings of fact on the owner of the land, the legislative body of the city or county in whose jurisdiction the land is located, and upon any other interested persons. If the Department agrees to the proposed variance, the director and all of the owers of the land shall execute an instrument reflecting this agreement, shall particularly describe the real property affected by the variance, and the owner shall record the instrument in the county in which the land is located within ten (10) days of the date of execution.

4.02 <u>Termination</u>. Any Owner or, with the Owner's consent, an Occupant of the Property or a portion thereof may apply to the Department for a termination of the Restrictions as they apply to all or any portion of the Property on the ground that the waste no longer creates a significant existing or potential hazard to present or future public health or safety. Any

application shall contain sufficient evidence for the Department to make a finding upon any or all of the following grounds:

A. The hazardous waste which caused the land to be contaminated has since been removed or altered in a manner which precludes any significant existing or potential hazard to present or future public health.

B. New scientific evidence is available concerning either of the following:

1. The nature of the hazardous waste contamination; or

2. The geology or other physical environmental characteristics of the contaminated land.

Upon making a decision to approve or deny the proposed termination, the Director shall issue and cause to be served the decision and findings of fact on the owners of the land, the legislative body, and the city or county in whose jurisdiction the land is located, and upon any other interested person. If the Department approves, in writing, the proposed termination of the Restrictions, the Director and all of the owners of the land shall record or cause to be recorded, a termination of the Restrictions which shall particularly describe the real property subject to the Restrictions and which shall be indexed by the recorder in the grantor index in the name of the record title

owner of the real property subject to the Restrictions, and in the grantee index in the name of the Department.

4.03 Term. Unless terminated in accordance with paragraph 4.02 above, by law or otherwise, this Covenant shall continue in effect in perpetuity.

ARTICLE V

MISCELLANEOUS

5.01 No Dedication Intended. Nothing set forth herein shall be construed to be a gift or dedication, or offer of a gift or dedication, of the Property or any portion thereof to the general public or for any purposes whatsoever.

5.02 Notices. Whenever any person gives or serves any notice, demand, or other communication with respect to this Covenant, each such notice, demand, or other communication shall be in writing and shall be deemed effective 1) when delivered, if personally delivered to the person being served or to an officer of a corporate party being served or official of a government agency being served, or 2) three (3) business days after deposit in the mail if mailed by United States mail, postage paid certified, return receipt requested:

To: Harold Logsdon
Coast Wood Preserving, Inc.
P.O. Box 673
Ukiah, CA 95482

Copy To: Department of Health Services
Toxic Substances Control Division
Region 2
2151 Berkeley Way, Annex 7
Berkeley, CA 94704
Attention: Regional Section Chief

5.03 Partial Invalidity. If any portion of the Restriction set forth herein or terms is determined to be invalid for any reason, the remaining portion shall remain in full force and effect as if such portion had not been included herein.

5.04 Article Headings. Headings at the beginning of each numbered article of this Covenant are solely for the convenience of the parties and are not a part of the Covenant.

5.05 Recordation. This instrument shall be executed by the Covenantor, and by the Director, California Department of Health Services. This instrument shall be recorded by the Owners in the County of Mendocino within ten (10) days of the date of execution.

5.06 <u>References</u>. All references to Code sections include successor provisions.

IN WITNESS WHEREOF, the parties execute this Covenant as of the data set forth above.

COAST WOOD PRESERVING, INC.

By: Harold W. Logsdon
Harold W. Logsdon

Title: President

Date: Sept. 25th 1989

DEPARTMENT OF HEALTH SERVICES

By: Howard K. Hatayama
Howard K. Hatayama

Title: Reg Administrator, TSCP

Date: 10/3/89

STATE OF CALIFORNIA)

)

COUNTY OF ALAMEDA)

On Oct. 3, 1989, before me, the undersigned, a Notary Public in and for said state, personally appeared Howard K. Hatayama, personally known to me or proved to me on the basis of satisfactory evidence to be the person who executed the within instrument as Regional Administrator, Region 2, Toxic Substances Control Program, Department of Health Services, of the agency that executed the within instrument, and acknowledged to me that such agency executed the same.

WITNESS my hand and official seal.

~~OFFICIAL SEAL CHARLOTTE M JACKSON NOTARY PUBLIC - CALIFORNIA ALAMEDA COUNTY My comm. expires MAR 23, 1990~~

OFFICIAL SEAL
CHARLOTTE M JACKSON
NOTARY PUBLIC - CALIFORNIA
ALAMEDA COUNTY
My comm. expires MAR 23, 1990

Charlotte M. Jackson

Notary Public in and for said County and State

COURT PAPER
STATE OF CALIFORNIA
STD. 113 (REV. 8-72)

85 34769

STATE OF CALIFORNIA)

)

COUNTY OF STANISLAUS)

On Sept. 25, 1989, before me, the undersigned, a Notary Public in and for said state, personally appeared Harold Logsdon, personally known to me or proved to me on the basis of satisfactory evidence to be the person who executed the within instrument as President of the corporation that executed the within instrument, and acknowledged to me that such corporation executed the same pursuant to its bylaws or a resolution of its board of directors.

WITNESS my hand and official seal.

Alicia Isley

Notary Public in and for said County and State

OFFICIAL SEAL
ALICIA ISLEY
NOTARY PUBLIC — CALIFORNIA
COUNTY OF STANISLAUS
My Comm. Expires January 11, 1993

EXHIBIT A

The description of the two lots are as follows:

BEGINNING at the point of intersection of the South line of Lot 70 of the Yokayo Rancho, with the East line of Parcel One, as conveyed in the deed executed by Edgar W. Dutton et al. to State of California, dated November 29, 1961, recorded February 1, 1962, in Volume 588 of Official Records, page 142, Mendocino County Records; thence along the exterior boundary of said Parcel One, North 5 degrees 52' 45" West 342.86 feet; thence continuing North 5 degrees 52' 45" West 145.0 feet; thence North 80 degrees 37' 15" East 386.91 feet to the South line of the 50 foot road described in the deed to City of Ukiah, recorded June 8, 1956 in Volume 432 of Official Records, page 543, Mendocino County Records; thence along the South line of said road Easterly to the West line of Parcel Two as conveyed in said deed (588 O.R.142); thence along said West line of Parcel Two South 7 degrees 20' 46" East 354.23 feet to the said South line of Lot 70; thence Westerly along said South line to the point of beginning.

PARCEL 2, as numbered and designated on the Parcel Map filed April 24, 1974 in Map Case 2, Drawer 23, Page 89, Mendocino County Records.

APPENDIX C

1994 AOC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX

In the matter of: Coast Wood Preserving, Inc., Harold W. Logsdon, Joyce J. Logsdon, Cordes P. Langley, and Marie J. Langley, Respondents.	CERCLA Docket No. 95-06 ADMINISTRATIVE ORDER ON CONSENT
Proceeding Under Section 122(h)(1) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (42 U.S.C. § 9622(h)(1)) as amended by the Superfund Amendments and Reauthorization Act of 1986	

This Administrative Order on Consent ("AOC" or "Order") is issued by the United States Environmental Protection Agency ("EPA") and is agreed to by Coast Wood Preserving, Inc. ("CWP"), Harold W. Logsdon, Joyce J. Logsdon, Cordes P. Langley, and Marie J. Langley (collectively "Respondents"). The purposes of this Order are: (1) for EPA to recover past response costs incurred and, as provided by paragraph 5 below, future response costs to be incurred by the United States at or in connection with the Coast Wood Preserving Superfund Site ("Site") in Ukiah, California; (2) to provide for the establishment of a trust fund by Respondents for the payment of future response costs to be incurred at or in connection with the Site; and (3) to resolve the liability of the Respondents for such costs.

EPA is authorized to enter into this Order pursuant to the authority vested in the Administrator of the EPA by Section 122(h)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, Pub. L. No. 99-499 ("CERCLA"), which authority has been delegated to the Regional Administrators of the EPA by EPA Delegation No. 14-14-D (Sept. 13, 1987), and redelegated to the Director, Hazardous Waste Management Division, EPA Region IX.

WHEREAS, EPA alleges that hazardous substances as defined by Section 101(14) of CERCLA, 42 U.S.C. § 9601(14), are present at the Site and that such hazardous substances have been or are threatened to be released into the environment from the Site;

WHEREAS, EPA alleges that the Site is a "facility" as defined in Section 101(9) of CERCLA, 42 U.S.C. § 9601(9);

WHEREAS, EPA alleges that such releases or threatened releases required response action to be undertaken at the Site

pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604, and will require further response action to be undertaken in the future;

WHEREAS, EPA alleges that it has incurred past response costs at or in connection with the Site of at least $200,000.00 through February 28, 1994, including accrued interest pursuant to Section 107(a) of CERCLA, and that further response costs will be incurred in the future;

WHEREAS, EPA alleges that the Respondents are liable parties pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), and are jointly and severally liable for response costs incurred and to be incurred at or in connection with the Site;

WHEREAS, the Attorney General or her designee has issued prior written approval of the settlement embodied in this Order pursuant to Section 122(h)(1) of CERCLA; and

WHEREAS, EPA and the Respondents desire to settle certain claims arising from the Respondents' alleged involvement with the Site without litigation and without the admission or adjudication of any issue of fact or law;

NOW, THEREFORE, in consideration of the promises herein, and intending to be legally bound hereby, it is ordered and agreed as follows:

1. This Order shall be binding upon EPA and shall be binding upon the Respondents and their successors and assigns. Each signatory to this Order represents that he or she is fully authorized to enter into the terms and conditions of this Order and to bind legally the party represented by him or her. The Respondents agree to undertake all actions required by this Order. The Respondents consent to the issuance of this Order and will not contest EPA's authority to enter into this Order or to implement or enforce its terms. Respondents participation in this Order shall not be deemed to be an admission of liability as to any of the facts asserted herein by EPA.

2. The Respondents agree to pay to the Hazardous Substance Superfund a total of $161,000.00, in reimbursement of EPA's past costs under the following terms: 1) $100,000.00 shall be paid within ten (10) days of the effective date of this Order; and 2) the remaining $61,000.00 shall be paid in equal installments of $30,500.00, plus interest accurred on all unpaid balances at the rate specified for interest on investments of the Hazardous Substance Superfund in accordance with 42 U.S.C. § 9607(a), over the succeeding two years after the effective date of this Order. "Past Response Costs" shall mean those costs incurred by EPA relating to the Site prior to and including February 28, 1994.

3. The Respondents' payments shall be made by checks made payable to "EPA-Hazardous Substance Superfund." The Respondents may submit their payments by one or more checks, but they are jointly and severally liable for payment of all amounts due under this Order. The check(s) shall reference the name and address of the Respondents, the site name and identification number, and the EPA docket number for this action and shall be sent by the Respondents to:

EPA Region IX
ATTN: Superfund Accounting
P.O. Box 360863M
Pittsburgh, PA 15251

4. The Respondents shall simultaneously send a copy of the check(s) to:

Andrew Lincoff
Mail Code H-6-5
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105

In addition, unless otherwise notified by EPA or specified herein, all other correspondence and notifications to EPA required by or pertaining to this Order or the Trust Fund shall be sent to the above address.

5. Respondents agree to pay all Future Response Costs incurred by EPA relating to the Site in accordance with the terms of this paragraph and paragraph 9(k). "Future Response Costs" shall mean all costs incurred by EPA relating to the Site from and after March 1, 1994, including but not limited to indirect costs and oversight costs. "Future Response Costs" as defined in this Section shall not include any amounts that Respondents have paid into the Trust Fund pursuant to Paragraph 6 of this Order. As long as EPA is not the "lead agency" as defined by 40 C.F.R. § 300.5 and any amendments thereto, Respondents shall be required to reimburse EPA no more than $3,000.00 in "future response costs" in any given year up to and including the year of completion of the soil remediation at the Site. This limitation shall not apply if EPA becomes the "lead agency," as defined by 40 C.F.R. § 300.5 and any amendments thereto, at the Site. Should EPA's "future response costs" exceed $3,000.00 in any given year, all costs in excess of $3,000.00 shall be included in the following year's future response costs. At the completion of the soil remediation at the Site, Respondents agree to pay all unreimbursed future response costs to the extent provided by paragraph 9(k). EPA shall provide a cost summary of its response costs incurred to Respondents no more often than annually, in the form of EPA's Agency Financial Management System cost summary data (SPUR Report). Respondents reserve the right to demonstrate that EPA's cost summary contains accounting errors. Any such

disputed costs shall be resolved in accordance with the dispute resolution provision contained in Section 14 of this Order. The Respondents shall reimburse EPA for all other response costs identified in the cost summary within thirty (30) days from Respondents' receipt of the cost summary, in accordance with the procedures set forth in Paragraphs 3 and 4 of this Order.

6(a). Within ten (10) days of the effective date of this Order, as required by the Record of Decision (ROD) issued by EPA dated September 29, 1989, Respondent Coast Wood shall establish a Trust Fund for the purposes of: (1) paying the costs of future response action(s), including but not limited to soil remediation, to be conducted at the Site in accordance with the ROD and any future amendments thereto; and (2) reimbursing EPA and the California Department of Toxic Substances Control ("DTSC") for any unreimbursed response costs, as provided in Section 9(k) of this Order. The total amount of principal the Respondent Coast Wood is required to place into the Trust Fund shall be five hundred thousand dollars ($500,000). The Trust Fund shall be funded in installment payments, as set forth in subparagraph (b) of this paragraph. In the event Respondents establish that no federally insured financial institution is willing to serve as Trustee for the Trust Fund, the parties may select a mutually agreeable independent third party to act in this capacity. Should the Coast Wood Preserving facility cease wood-treating operations prior to December 31, 2003, it shall remain liable for continuing to make the remaining annual installment payments into the Trust Fund until the full amount of the principal is funded. In the event Respondent Coast Wood fails at any time to make any payment in the amount or within the time frames set forth in this paragraph, the missed payment and all remaining installment payments listed in this paragraph shall become due and payable immediately by Respondent Coast Wood.

(b) Within either ten (10) days of the effective date of this Order, or the time when Respondent CWP's next $50,000 payment would be due to the Certificate of Deposit (Wells Fargo Bank, N.A., account number 1256-066119-001, in Turlock, California), which ever is later, but in no event later than December 31, 1994, Respondent CWP shall pay into the Trust Fund $50,000 in principal. Respondent CWP shall thereafter, on an annual basis, make annual payments of $50,000 into the Trust Fund until such time as the principal amount of the Trust Fund required by paragraph 6(a) is fully financed. The Respondent CWP shall be permitted to use the total amount of principal and accrued interest on the current Certificate of Deposit account established by Respondent Coast Wood (Wells Fargo Bank, N.A., account number 1256-066119-001, in Turlock, California) as a portion of the principal to be paid into the Trust Fund. The total amount of principal and accrued interest on the current Certificate of Deposit shall be transferred to the Trust Fund within ten (10) days after the expiration of the current terms of

current terms of the Certificate of Deposit account.

7. Respondents represent that there exists no mortgage or other known encumbrances on the title to the property which comprises the Site. As assurance of Respondents' ability to fund the total principal amount of the Trust Fund set forth in Paragraph 6(a) above ($500,000), Respondents agree to the United States filing a lien on the Site property pursuant to section 107(l) of CERCLA in the full amount required to be placed into the Trust Fund and that this agreement shall serve as notice of the filing of such lien as required by section 107(l)(3). In the event other encumbrances presently not known to Respondents exist on the Site property, Respondents agree to provide financial assurances of their ability to fund the total principal amount of the Trust Fund in some other means mutually agreeable to the parties. If Respondents are required to provide financial assurances other than the lien mentioned above, Respondents may reduce the amount of financial assurance required to be maintained by this Paragraph each year by the amount of the payment made to the Trust Fund after such payment has been made pursuant to subparagraph 6(b) above. EPA may, after consultation with DTSC, disapprove the financial assurance mechanism presented if in EPA's determination, after consultation with DTSC, it does not provide adequate assurance that Respondents are able to fund the total amount of principal remaining to be funded in the Trust Fund. Respondents shall thereafter submit an alternative financial mechanism to EPA within ten (10) days of EPA's notice of disapproval of the prior financial assurance mechanism. If Respondents fail to submit an alternative financial assurance mechanism for EPA's approval within ten (10) days of notification of EPA's disapproval, Respondents shall be deemed to be in violation of this Order. If EPA, after consultation with DTSC, disapproves the alternative financial assurance mechanism submitted by Respondents, Respondents shall have 10 days to correct any deficiencies. If Respondents fail to correct any such deficiencies within the 10 day period, Respondents shall be deemed to be in violation of the this Order and penalties shall accrue as provided in paragraph 12 of this Order. Penalties shall continue to accrue until such time as Respondents cure the deficiencies regarding the alternative financial mechanisms disapproved by EPA pursuant to this paragraph. EPA agrees to stay imposition of any penalties due as a result of the failure to provide an acceptable alternative financial assurance mechanism provided Respondents continue to make timely payments to the Trust Fund. Should Respondents fail to make timely payments to the Trust Fund, the EPA may seek all penalties which have accrued from the date Respondents were otherwise required to cure any deficiencies regarding their proposed alternative financial mechanisms pursuant to the paragraph.

8. Upon or prior to the effective date of this Order, Respondents shall (1) provide to EPA for approval, after

consultation with DTSC, a draft copy of the instrument establishing the Trust Fund ("Trust Agreement"), primarily to ensure that the trust funds will be managed as set forth by this Order, and (2) notify EPA and DTSC of the identity and qualifications of the Trustee(s). Neither EPA nor DTSC, through their approval of and/or concurrence in the terms and conditions of the Trust Agreement, guarantees the monetary sufficiency of the Trust Fund nor the legal sufficiency of the Trust Agreement.

9. The Trust Agreement shall, at a minimum, provide that:

(a) DTSC shall be the Primary Beneficiary, and the United States Environmental Protection Agency shall be the Third-Party Beneficiary;

(b) The Trustee shall be an independent third party, neither related to nor employed by any Respondent;

(c) All funds must be invested in insured, or federally issued, fixed income securities;

(d) Principal and interest must be held in a suitable account with a financial institution that is insured by the FDIC or a solvent state insurance agency;

(e) The Trustee must provide either annual or quarterly accounting statements to EPA Region IX and DTSC. As to EPA Region IX, such correspondence should be sent to:

Andy Lincoff
Mail Code H-6-3
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105

As to DTSC, all correspondence should be sent to:

Barbara Cook, Site Mitigation Branch Chief
California Department of Toxic Substances Control
Region 2
700 Heinz Avenue, Suite 200
Berkeley, California 94710;

(f) All orders, instructions, requests for payment, etc., to the Trustee shall be in writing, and the Trustee shall promptly provide copies to EPA and DTSC. With respect to requests for payments from the Trust Fund, the Trust Agreement shall further provide that:

(i) All requests for payments by Respondents from the Trust Fund shall specifically itemize all costs for which payment is requested. The itemization shall include sufficient

detail to document to EPA and DTSC that the costs incurred are consistent with the National Contingency Plan, 40 CFR § 300 et seq., and the Record of Decision ("ROD") for the Site; and

(ii) After receipt of a request for payment, the Trustee shall provide written notification and a copy of the itemized request for payment to EPA Region IX, at least thirty (30) days in advance of any payment from the Trust Fund. Upon request by EPA and/or DTSC, the party requesting payment shall provide additional documentation of such costs.

(g) If, pursuant to an Order or agreement with DTSC, the Respondents conduct future remedial actions at the Site required by the ROD and any amendments thereto, the Respondents may submit requests for payment from the Trust Fund through DTSC. All such requests for payment are subject to the requirements set forth in subsection 9(f) of this Order;

(h) The Trustee is not authorized to make any payments to Respondents from the Trust Fund pursuant to subsection 9(g) of this Order if: 1) Respondents have failed to make any payment required by Paragraphs 2, 5, or Respondent Coast Wood has failed to make any payment required by paragraphs 6(a), and 6(b) of this Order; or 2) EPA and/or DTSC determines that the costs being sought were not incurred in a manner consistent with the NCP, 40 C.F.R. § 300 et seq.;

(i) As long as the California Department of Toxic Substances Control remains the "lead agency" for the Site, as defined in 40 C.F.R. § 300.5 and any amendments thereto, DTSC may draw upon the amount in the Trust Fund to pay costs incurred in performing response action(s) at the Site; provided, however, that in the event that EPA becomes the lead agency for the Site, DTSC may no longer draw upon the Trust Fund. Should EPA become lead agency pursuant to this subparagraph, Respondent Coast Wood shall continue to be able to request payment from the Trust Fund, in accordance with paragraphs 9(f)(i) and 9(g), for all response actions it performs at the Site. If at any time after EPA becomes lead agency at the Site, Respondent Coast Wood fails to perform any response action required by the ROD and any future amendments thereto, and EPA is required to perform the same, EPA may direct the Trustee to transfer all amounts remaining in the Trust Fund to a Hazardous Substance Superfund Special Account pursuant to section 122(b)(3) of CERCLA, to be used to pay response costs incurred by EPA relating to the Site;

(j) Respondents shall bear all costs related to the establishment and maintenance of the Trust Fund. Any interest earned on the Trust Fund shall be included in the Trust Fund to be used to pay costs incurred in performing response action(s) as set forth herein; and

(k) Upon completion of the soil remediation and any other response action at or in connection with the Site, including without limitation, all response actions required by the ROD and any amendments thereto, any funds remaining in the Trust Fund shall be disbursed as follows: First, to EPA or DTSC, whichever agency is the "lead agency," as defined by 40 C.F.R. § 300.5 and any amendments thereto, at the time of completion of all response actions at or in connection with the Site, in payment of response costs incurred which have not been reimbursed by the Respondents. Second, to the extent any funds remain after reimbursement to the lead agency, to EPA or DTSC, whichever is not the "lead agency," as defined by 40 C.F.R. § 300.5 and any amendments thereto, at the time of completion of all response actions at or in connection with the Site, in payment of response costs incurred which have not been reimbursed by the Respondents. Third, any funds remaining in the Trust Account following payment of EPA and State costs shall be refunded to Respondent Coast Wood. In the event that the payments required by paragraph 5 and/or the amount of the Trust Fund proves insufficient to reimburse the United States its total future costs at the Site, the United States, by this agreement, reserves its rights to seek recovery of these costs in the future.

10. Any disputes between EPA and DTSC relating to the Trust Fund, including but not limited to payments from the Fund pursuant to subsection 9(f) of this Order, shall be resolved pursuant to the Multisite Cooperative Agreement (MSCA) governing the Coast Wood Preserving Site, and any other applicable regulations, including but not limited to 40 CFR § 31.70.

11. In the event that any payment required by Respondents by Paragraphs 2, 5, or any payment required by Respondent Coast Wood under paragraphs 6(a) and 6(b) of this Order is not made when due, interest shall accrue on the unpaid balance from the due date through the date of payment, at the rate specified for interest on investments of the Hazardous Substance Superfund in accordance with 42 U.S.C. § 9607(a). In addition, if any payment required by Paragraphs 2, 5, or any payment required by Respondent Coast Wood under paragraphs 6(a) and 6(b) are not paid by the required date, the Respondents shall pay to EPA, as a stipulated penalty, $100 per day that such payment is late. Stipulated penalties are due and payable within thirty (30) days of the Respondents' receipt from EPA of a demand for payment of the penalties. All payments to EPA under this Paragraph shall be made in accordance with the requirements of Paragraphs 3 and 4 of this Order. Penalties shall accrue as provided above regardless of whether EPA has notified the Respondents of the violation or made a demand for payment, but need only be paid upon demand.

12. In addition to any other remedies or sanctions available to EPA, any Respondent who fails or refuses to comply with any term or condition of this Order shall be subject to

enforcement action pursuant to Section 122(h)(3) of CERCLA, 42 U.S.C. § 9622(h)(3), and to civil penalties pursuant to Sections 122(l) and 109 of CERCLA, 42 U.S.C. §§ 9622(l) and 9609. If the United States must bring an action to collect any payment required by this Agreement, the Respondents shall reimburse the United States for all costs of such action, including but not limited to costs of attorney time.

13. Subject to Paragraph 15 of this Order, upon payment of the amount specified in Paragraph 2 of this Order, EPA agrees that the Respondents shall have resolved any and all civil liability to EPA under Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), for reimbursement of EPA's Past Response Costs incurred at or in connection with the Site as of February 28, 1994. Subject to Paragraph 15 of this Order, upon payment by Respondents of the Future Response Costs billed by EPA pursuant to Paragraph 5 above, and upon payments by Respondent Coast Wood into the Trust Fund pursuant to Paragraph 6 above, the Respondents shall also have resolved any and all civil liability to EPA under Section 107(a) of CERCLA for the specific amounts paid.

14. (a) Any disputes concerning the United States' Future Response Costs, payable pursuant to the terms of Paragraph 5, shall be resolved in the following manner. Within thirty (30) days from receipt of EPA's cost summary SPUR Report, Respondents shall notify the EPA contact listed in Paragraph 4 of their objections to EPA's costs. Respondents' objections shall be made in writing and shall define the dispute, state the basis of Respondent's objections, and be sent certified mail, return receipt requested. EPA shall not be obligated to provide additional cost documentation beyond the SPUR Report, but may do so at its discretion. All costs not disputed shall be paid pursuant to Paragraph 5 of this Order. EPA and the Respondents shall have fourteen (14) days from the date of EPA's receipt of Respondents' objections to reach agreement on the disputed costs. EPA may extend this period as needed. If an agreement is reached, Respondents' shall pay the agreed amount within fourteen (14) days after the date of such agreement.

(b) If an agreement is not reached within said time period including extensions, EPA or Respondents may request a determination by EPA Region IX's Deputy Director for Superfund. The Deputy Director's determination shall constitute EPA's final decision. Respondents shall pay the costs owed pursuant to EPA's final decision, regardless of whether Respondents agree with the decision, within fourteen (14) days after the date of said decision. Respondents' payment shall include interest on the amount due, calculated from the date of Respondents' receipt of EPA's cost summary to the date of payment, at the rate specified for interest on investments of the Hazardous Substance Superfund in accordance with 42 U.S.C. § 9607(a).

(c) If Respondents fail to make payment when due under this Section, EPA reserves the right to seek statutory penalties and/or any other appropriate relief.

(d) Any disputes arising between Respondents and EPA concerning the Trust Fund or other provisions of this Order shall be resolved according to the procedures set forth in paragraphs (a), (b), and (c) of this Section.

15. Nothing in this Order is intended to be nor shall it be construed as a release, covenant not to sue, or compromise of any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or in equity, which EPA, DTSC, or any other governmental agency or instrumentality may have against the Respondents for:

(a) any liability as a result of failure to make the payments required by Paragraphs 2, 5, and 6(a) and 6(b) of this Order or other failure to comply with the terms of this Order; or

(b) any liability not expressly included in Paragraph 13 above, including, without limitation, any liability for i) injunctive relief at the Site; ii) response costs other than those specifically described under Paragraphs 2, 5, and 6(a) and 6(b) above, including but not limited to costs of soil remediation or other response action that exceed the amount of the Trust Fund; iii) damages for injury to or loss or destruction of natural resources; or iv) criminal liability.

16. Nothing in this Order is intended to be nor shall it be construed as a release, covenant not to sue, or compromise of any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or in equity, which EPA, DTSC, or any other governmental agency or instrumentality may have against any person, firm, corporation or other entity not a signatory to this Order.

17. The Respondents agree not to assert any claims or causes of action against the United States or the Hazardous Substance Superfund arising out of response activities undertaken at, or relating in any way to, the Site, or to seek any other costs, damages, or attorney's fees from the United States, its agencies, employees or contractors arising out of response activities undertaken at, or relating in any way to, the Site. The Respondents waive any right they might have to seek reimbursement from EPA pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, for any costs pertaining to the Site.

18. Respondent Coast Wood Preserving, Inc., agrees to indemnify, save and hold harmless the United States, its officials, agents, contractors, subcontractors, employees and representatives from any and all claims or causes of action: a)

arising from or on account of acts or omissions of Respondent Coast Wood Preserving, Inc.'s, officers, directors, employees, agents, contractors, subcontractors, successors, and assigns in conducting response actions at the Site relating to this Order; and b) for damages or reimbursement arising from or on account of any contract, agreement, or arrangement between Respondent Coast Wood Preserving, Inc., and any person(s) for performance of work at or relating to the Site, including claims arising out of construction delays. Respondent Coast Wood Preserving, Inc., also agrees to pay the United States all costs incurred by the United States, including litigation costs arising from or on account of claims made against the United States based on any of the acts or omissions referred to in this Section.

19. With regard to claims for contribution against the Respondents for matters addressed in this Order, the parties hereto agree that the Respondents are entitled, as of the effective date of this Order, to such protection from contribution actions or claims as is provided in Section 122(h)(4) of CERCLA.

20. This Order shall be subject to a thirty-day public comment period pursuant to Section 122(i) of CERCLA. In accordance with Section 122(i)(3) of CERCLA, EPA may modify or withdraw its consent to this Order if comments received disclose facts or considerations which indicate that this Order is inappropriate, improper or inadequate.

21. The effective date of this Order shall be the date upon which EPA issues written notice to the Respondents that the public comment period pursuant to Paragraph 20 of this Order has closed and that comments received, if any, do not require modification of or EPA withdrawal from this Order.

IT IS SO AGREED:

Respondent Coast Wood Preserving, Inc.:

By: Harold W. Logsdon 11/18/94

Harold W. Logsdon, President | Date

Harold W. Logsdon 11/18/94

Respondent Harold W. Logsdon | Date

Joyce J. Logsdon Nov. 18, 1994

Respondent Joyce J. Logsdon | Date

Respondent Cordes P. Langley | Date

Respondent Marie J. Langley | Date

IT IS SO AGREED:

Respondent Coast Wood Preserving, Inc.:

By: ______________________________ ______________________________
Harold W. Logsdon, President Date

______________________________ ______________________________
Respondent Harold W. Logsdon Date

______________________________ ______________________________
Respondent Joyce J. Logsdon Date

Cordes P. Langley 11/18/94
Respondent Cordes P. Langley Date

Marie J. Langley 11-21-94
Respondent Marie J. Langley Date

The above being agreed and consented to, IT IS SO ORDERED this 4th day of December, 1994.

U.S. Environmental Protection Agency

By: Keith Takata

for ~~Jeff~~ Zelikson, Director
Hazardous Waste Management Division
Region IX

APPENDIX D

Record of Decision

EPA/ROD/R09-89/038
1989

EPA Superfund
Record of Decision:

COAST WOOD PRESERVING
EPA ID: CAD063015887
OU 01
UKIAH, CA
09/29/1989

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

#SBP
STATEMENT OF BASIS AND PURPOSE:

THIS DOCUMENT SERVES AS EPA SELECTION OF THE REMEDIAL ACTION FOR THE COAST WOOD PRESERVING, INC. SITE. THE CALIFORNIA DEPARTMENT OF HEALTH SERVICES, TOXIC SUBSTANCES CONTROL DIVISION, REGION 2, (CDHS) HAS APPROVED THIS REMEDIAL ACTION IN CONFORMANCE WITH: SECTION 13000 AND 13304 OF THE CALIFORNIA WATER CODE, STATE OF CALIFORNIA HEALTH AND SAFETY CODE SECTION 25356.1, THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA) AND THE NATIONAL CONTINGENCY PLAN.

THIS EPA SELECTION OF REMEDY IS BASED UPON THE CDHS REMEDIAL ACTION PLAN, THE RESPONSIVENESS SUMMARY, THE REMEDIAL INVESTIGATION, THE FEASIBILITY STUDY, AND THE ADMINISTRATIVE RECORD FOR THIS SITE. THE ATTACHED INDEX LISTS THE ITEMS COMPRISING THE ADMINISTRATIVE RECORD.

DESCRIPTION OF REMEDIAL ACTION

THE SELECTED REMEDY PROVIDES FOR FINAL CLEAN-UP REQUIREMENTS RELATED TO ONSITE SOILS AND GROUNDWATER AND THE PREVENTION OF OFFSITE MIGRATION OF CONTAMINANTS. IN ADDITION, A CONTINGENCY IS PROVIDED FOR THE REMEDIATION OF OFFSITE GROUNDWATER IN THE EVENT THAT CHROMIUM LEVELS RISE OVER ACCEPTABLE LEVELS.

OVER THE YEARS, A NUMBER OF REMEDIAL MEASURES HAVE BEEN UNDERTAKEN BY COAST WOOD PRESERVING, INC. TO REDUCE THE MIGRATION OF CHROMIUM, COPPER AND ARSENIC CONTAMINATION AND TO BEGIN GROUNDWATER REMEDIATION. THESE MEASURES INCLUDED CONSTRUCTING SURFACE WATER RUN-OFF BERMS, PAVING OVER EXPOSED SOIL ZONES, AND CONSTRUCTING ROOFS OVER THE RETORT AREAS TO REDUCE THE POTENTIAL FOR ADDITIONAL SOIL, STORM WATER AND GROUNDWATER CONTAMINATION. IN 1983, WITHOUT REGULATORY AGENCY APPROVAL, COAST WOOD PRESERVING CONSTRUCTED A 300-FOOT SLURRY CUTOFF WALL ALONG THE EASTERN BOUNDARY OF THE SITE. A GROUNDWATER EXTRACTION TRENCH WAS INSTALLED ON THE UPGRADIENT SIDE OF THE SLURRY WALL. EXTRACTED GROUNDWATER IS PIPED TO AN ON-SITE ELECTROCHEMICAL TREATMENT FACILITY PRIOR TO REUSE, REINJECTION OR DISCHARGE. THE SLURRY WALL AND EXTRACTION WELL HAVE BEEN EFFECTIVE IN REDUCING FURTHER OFF-SITE MIGRATION OF HEAVY METALS.

UNDER AGREEMENT WITH THE STATE OF CALIFORNIA, COAST WOOD PRESERVING WILL BE RESPONSIBLE FOR THE REMEDIATION OF CONTAMINATED SOILS AT THE TIME OF CLOSURE OF THE FACILITY PROJECTED TO BE IN TEN (10) YEARS. A TRUST FUND WILL BE ESTABLISHED WITH ANNUAL PAYMENTS TO BE MADE BY COAST WOOD PRESERVING, INC. TO FUND THIS PORTION OF THE SITE REMEDIATION. TREATABILITY STUDIES WILL BE CONDUCTED PRIOR TO CDHS AND EPA SELECTION OF THE MOST EFFECTIVE AND COST EFFICIENT TECHNOLOGY.

#DE
DECLARATION

EPA UNDER CERCLA, HAS SELECTED THIS GROUNDWATER REMEDY FOR THE COAST WOOD PRESERVING, INC. SITE. THE REMEDY IS PROTECTIVE OF HUMAN HEALTH AND THE ENVIRONMENT, ATTAINS FEDERAL AND STATE REQUIREMENTS THAT ARE APPLICABLE OR RELEVANT AND APPROPRIATE TO THE REMEDIAL ACTION, AND IS COST- AND TIME EFFECTIVE. THIS REMEDY SATISFIES FEDERAL STATUTORY PREFERENCES FOR REMEDIES THAT REDUCE TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS AS A PRINCIPAL ELEMENT. IT ALSO UTILIZES PERMANENT SOLUTIONS TO THE MAXIMUM EXTENT PRACTICABLE.

AS THIS REMEDY WILL RESULT IN HAZARDOUS SUBSTANCES REMAINING ON-SITE ABOVE HEALTH BASED LEVELS, A REVIEW WILL BE CONDUCTED BY EPA EACH FIVE (5) YEARS AFTER COMMENCEMENT OF REMEDIAL ACTION TO ENSURE THE REMEDY CONTINUES TO PROVIDE ADEQUATE PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT. IF THIS SELECTED REMEDIAL ACTION DOES NOT MEET THE GOALS AND CLEANUP OBJECTIVES IDENTIFIED IN THE REMEDY, OR IS NOT SUFFICIENTLY PROTECTIVE OF HUMAN HEALTH AND THE ENVIRONMENT, THEN EPA MAY, UNDER THE AUTHORITIES OF CERCLA, REQUIRE ADDITIONAL RESPONSE ACTION FROM COAST WOOD PRESERVING, INC.

DATE:09/29/89 DANIEL W. MCGOVERN
REGIONAL ADMINISTRATOR

#INT

1.0 INTRODUCTION

SINCE JUNE 1980, A NUMBER OF STUDIES HAVE BEEN CONDUCTED TO INVESTIGATE THE PRESENCE OF CHROMIUM, COPPER, AND ARSENIC IN THE SUBSURFACE ENVIRONMENT AT THE COAST WOOD PRESERVING, INC. (CWP) FACILITY (THE SITE) IN UKIAH, CALIFORNIA. THE INVESTIGATIONS WERE DESIGNED TO CHARACTERIZE SURFACE AND SUBSURFACE CONDITIONS AND DELINEATE THE AREAL AND VERTICAL EXTENT OF CHROMIUM, COPPER, AND ARSENIC IN SOIL AND GROUND WATER AT THE SITE. CONCURRENT WITH THE INVESTIGATIONS, A NUMBER OF INTERIM REMEDIAL MEASURES HAVE BEEN IMPLEMENTED TO CONTAIN THE CHROMIUM PLUME IN GROUND WATER AND REMEDIATE SUBSURFACE CONDITIONS.

THE STATE AND FEDERAL AGENCIES RESPONSIBLE FOR OVERSEEING THE CWP INVESTIGATIONS INCLUDE THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, NORTH COAST REGION (RWQCB), DEPARTMENT OF HEALTH SERVICES (DHS), AND US ENVIRONMENTAL AGENCY (EPA). THROUGHOUT THIS REPORT, THE RWQCB, DHS, AND EPA ARE REFERRED TO COLLECTIVELY AS "THE REGULATORY AGENCIES."

IN COMPLIANCE WITH SECTION 25356.1 OF THE CALIFORNIA HEALTH AND SAFETY CODE (1986), THE REGULATORY AGENCIES HAVE REQUESTED THAT CWP SUBMIT A REMEDIAL ACTION PLAN (RAP) TO ADDRESS SOIL AND GROUND WATER CONTAMINATION WHICH MAY HAVE ORIGINATED FROM CWP'S OPERATION. ON BEHALF OF CWP AND IN RESPONSE TO THIS REQUEST, GEOSYSTEM CONSULTANTS, INC. (GEOSYSTEM) SUBMITTED A PREDRAFT PAP (GEOSYSTEM, SEPTEMBER IS, 1986) TO THE REGULATORY AGENCIES FOR REVIEW. SUBSEQUENT TO THE SUBMITTAL OF THE PREDRAFT RAP, A NUMBER OF ADDITIONAL INVESTIGATIONS WERE PERFORMED AT THE SITE. ALSO, IN FEBRUARY 1987, THE DHS ISSUED A DRAFT GUIDANCE DOCUMENT FOR RAP PREPARATION. THE DRAFT GUIDANCE DOCUMENT PROVIDED THE FORMAT, CONTENT, AND PROCEDURES FOR PREPARATION, APPROVAL, AND IMPLEMENTATION OF THE RAP.

UTILIZING THE 'RESULTS OF ADDITIONAL INVESTIGATIONS AND CONSIDERING THE REGULATORY AGENCIES' REVIEW COMMENTS, A DRAFT RAP WAS PREPARED BY GEOSYSTEM IN ACCORDANCE WITH THE FEBRUARY 1987 DRAFT RAP GUIDELINES. SHE DRAFT RAP WAS SUBMITTED FOR REVIEW IN JULY 1987. IN SEPTEMBER 1987, THE DHS ISSUED A DETAILED OUTLINE FOR THE PREPARATION OF RAPS ENTITLED "DHS, POLICY AND PROCEDURE FOR REMEDIAL ACTION PLAN DEVELOPMENT AND APPROVED PROCESSES" (DHS, SEPTEMBER 1987). ALSO, IN SEPTEMBER 1987, THE REGULATORY AGENCIES PROVIDED REVIEW COMMENTS ON THE DRAFT RAP SUBMITTED IN JULY 1987. THE AGENCIES' COMMENTS AND THE CONTENT AND FORMAT OF THE MOST RECENT RAP GUIDELINES (DHS, SEPTEMBER 1987) WERE CONSIDERED IN THE PREPARATION OF DRAFT NO. 2 OF THE RAP, WHICH WAS ISSUED IN FEBRUARY 1988 (GEOSYSTEM, FEBRUARY 29, 1988). SUBSEQUENTLY, ON AUGUST 4, 1988, AGENCY COMMENTS ON DRAFT NO. 2 OF THE RAP WERE RECEIVED.1 ALSO, ON DECEMBER 16, 1988, THE DHS ISSUED A REMEDIAL ACTION ORDER PROVIDING THE FRAMEWORK FOR FUTURE SITE ACTIVITIES, INCLUDING THE PREPARATION OF THE THIRD DRAFT OF THE RAP. ON FEBRUARY 3, 1989, GEOSYSTEM ISSUED THE THIRD DRAFT OF THE RAP FOR AGENCY REVIEW. AGENCY COMMENTS WERE CONSIDERED IN THE PREPARATION OF THE FINAL DRAFT RAP, WHICH WAS ISSUED ON MAY 3, 1989. ON AUGUST 1, 1989, THE DHS ISSUED A NUMBER OF COMMENTS AND CHANGES TO BE ADDRESSED IN THE FINAL RAP (DHS, AUGUST 1, 1989).

IT IS NOTED THAT THE RAP GUIDELINES PREPARED BY THE DHS ARE CONSISTENT WITH SECTION 25350, SUBPART F OF THE NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTINGENCY PLAN (US EPA, JULY 1985), SECTION 25356.1 OF THE CALIFORNIA HEALTH AND SAFETY CODE (1986), AND THE CALIFORNIA SITE MITIGATION DECISION TREE (DHS, JUNE 1985).

1.1 OBJECTIVE

ACCORDING TO THE SEPTEMBER 1987 DHS GUIDELINES FOR RAP PREPARATION, THE PURPOSE OF A RAP IS TO COMPILE AND SUMMARIZE SITE DATA GATHERED FROM THE REMEDIAL INVESTIGATION (RI) AND THE FEASIBILITY STUDY (FS), IN ORDER TO IDENTIFY, AND SUBSEQUENTLY DESIGN, PLAN AND IMPLEMENT A FINAL REMEDIAL ACTION FOR A HAZARDOUS SUBSTANCE RELEASE SITE." THE SPECIFIC OBJECTIVE OF THIS RAP IS TO PRESENT THE FINDINGS OF THE INVESTIGATIONS PERFORMED AT THE CUP SITE, THE RATIONALE FOR SELECTION OR REJECTION OF THE REMEDIAL ALTERNATIVES CONSIDERED, AND THE TIMEFRAME FOR REMEDIAL ACTION IMPLEMENTATION. THE RAP IS INTENDED TO PROVIDE AN OPPORTUNITY FOR THE PUBLIC AND OTHER INTERESTED PARTIES TO PARTICIPATE IN THE REMEDIAL ACTION DECISION-MAKING PROCESS. ACCORDING TO THE DHS, IF THE REMEDIAL ACTION PLAN IS FULLY IMPLEMENTED AND COMPLETED, "THE SITE WILL BE CERTIFIED AND TRANSFERRED TO A LIST OF SITES WHICH REQUIRE LONG TERM OPERATION AND MAINTENANCE."

1.2 SITE IDENTIFICATION

THE SITE IS KNOWN AS THE COAST WOOD PRESERVING, INC. (CUP) FACILITY AND IS LOCATED THREE MILES SOUTH OF UKIAH, CALIFORNIA, AT THE INTERSECTION OF HIGHWAY 101 AND TAYLOR DRIVE. THE SITE LOCATION IS SHOWN IN FIGURE 1. CWP HAS CONDUCTED WOOD PRESERVING OPERATIONS AT THE SITE SINCE 1971 AND THE FACILITY IS CURRENTLY ACTIVE. ADDITIONAL DETAILS OF CUP'S WOOD PRESERVING OPERATION ARE PRESENTED IN SECTION 3.2.1.

1.3 SCOPE AND REPORT ORGANIZATION

THE RAP INCLUDES RELEVANT BACKGROUND INFORMATION, A SUMMARY AND INTERPRETATION OF THE HYDROGEOLOGIC DATA, A SUMMARY OF SOIL AND GROUND WATER QUALITY DATA, A DESCRIPTION OF THE INTERIM REMEDIAL MEASURES IMPLEMENTED, A RISK ASSESSMENT, AND AN EVALUATION OF REMEDIAL ACTION ALTERNATIVES, IN ADDITION, THE RATIONALE FOR SELECTION OF THE PROPOSED REMEDIAL ACTIONS AND REJECTION OF HE OTHERS IS PRESENTED.

THE FORMAT AND ORGANIZATION OF THIS DOCUMENT ARE CONSISTENT WITH THE RAP GUIDELINES (DHS, SEPTEMBER 1987). AN EXECUTIVE SUMMARY, INCLUDING A BRIEF DESCRIPTION OF SIGNIFICANT FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS, IS PROVIDED IN SECTION 2.0. SECTION 3.0 PRESENTS A SITE DESCRIPTION, INCLUDING THE HISTORY OF WOOD PRESERVING OPERATIONS AND THE PHYSICAL CHARACTERISTICS OF THE SITE. SECTION 4.0 CONTAINS A SUMMARY OF THE GEOLOGIC, HYDROLOGIC, AND CHEMICAL CHARACTERISTICS OF SOIL, SURFACE WATER, AND GROUND WATER AT THE SITE AND IMMEDIATE VICINITY BASED ON THE REMEDIAL INVESTIGATIONS PERFORMED. SECTION 5.0 DESCRIBES THE INTERIM REMEDIAL MEASURES IMPLEMENTED DURING THE COURSE OF THE INVESTIGATIONS AT THE SITE. SECTION 6.0 SUMMARIZES POTENTIAL MIGRATION PATHWAYS AND CHROMIUM TOXICITY, AND EVALUATES THE POSSIBLE EXPOSURE OF THE CONTAMINANTS' TO POTENTIAL RECEPTORS.

SECTION 7.0 PRESENTS THE REMEDIAL ACTION ALTERNATIVES CONSIDERED TO ADDRESS SOIL AND GROUND WATER CONTAMINATION, INCLUDING ALTERNATIVE METHODS OF GROUND WATER TREATMENT AND DISCHARGE. IN ADDITION, THE RECOMMENDED REMEDIAL ACTION TO ADDRESS SOIL AND GROUNDWATER CONTAMINATION IS PRESENTED IN SECTION 7.0. THE RATIONALE FOR THE SELECTION OF THE PROPOSED REMEDIAL PLAN AND THE APPLICABLE REGULATIONS ARE ALSO PRESENTED IN THIS SECTION.

THE SCHEDULE FOR IMPLEMENTATION OF THE RAP IS PRESENTED IN SECTION 8.0. THE ALLOCATION OF FINANCIAL RESPONSIBILITY AND PROVISIONS FOR FINANCIAL ASSURANCE ARE PRESENTED IN SECTION 9.0. THE OPERATION AND MAINTENANCE REQUIREMENTS ARE DESCRIBED IN SECTION 10.0.

2.0 EXECUTIVE SUMMARY

THE REMEDIAL ACTION PLAN (RAP) PRESENTS THE RATIONALE, APPROACH, AND FRAMEWORK FOR THE PROPOSED REMEDIATION PROGRAM AT THE COAST WOOD PRESERVING, INC. (CWP) FACILITY IN UKIAH, CALIFORNIA.

2.1 APPLICABLE LAWS AND REGULATIONS

THE RAP HAS BEEN PREPARED IN ACCORDANCE WITH THE GUIDANCE DOCUMENT ENTITLED "REMEDIAL ACTION PLAN DEVELOPMENT AND APPROVAL PROCESS," ISSUED BY THE DHS (SEPTEMBER 1987). THE RAP IS ALSO CONSISTENT WITH THE FOLLOWING STATE AND FEDERAL REQUIREMENTS AND GUIDELINES:

- COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA) OF 1980, AS AMENDED BY THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986.
- RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) OF 1976, AS AMENDED BY THE HAZARDOUS AND SOLID WASTE AMENDMENTS (HSWA) OF 1984.
- SAFE DRINKING WATER ACT.
- CALIFORNIA CODE OF REGULATIONS, TITLE 22, DIVISION 4: ENVIRONMENTAL HEALTH (CHAPTER 1, ARTICLE 1; CHAPTER 2, ARTICLE 1; CHAPTER 30), JULY 1986.
- CALIFORNIA HEALTH AND SAFETY CODE.
- NORTH COASTAL BASIN WATER QUALITY CONTROL PLAN ADOPTED BY THE RWQCS.
- ALL ORDERS, INCLUDING SPECIFICATIONS, PROVISIONS, PROHIBITIONS, AND REQUIREMENTS ISSUED BY THE RWQCB.

- COURT ORDER BY THE STATE OF CALIFORNIA, OFFICE OF THE ATTORNEY GENERAL.

- NATIONAL CONTINGENCY PLAN, PERTINENT HAZARDOUS WASTE REGULATIONS UNDER 40 CFR, PARTS 260 TO 265; PART 300-68, JULY 1985.

- PORTER-COLOGNE WATER QUALITY CONTROL ACT, 1969.

2.2 BACKGROUND

SINCE 1980, A NUMBER OF INVESTIGATIONS HAVE BEEN PERFORMED TO DELINEATE THE AREAL AND VERTICAL EXTENT OF CHROMIUM IN SOIL AND GROUND WATER AT THE CWP SITE AND TO CHARACTERIZE HYDROGEOLOGIC CONDITIONS. SOIL QUALITY INVESTIGATIONS HAVE SHOWN THAT ELEVATED CHROMIUM AND ARSENIC CONCENTRATIONS EXIST IN THE UPPER 1 TO 2 FEED OF THE SOIL PROFILE NEAR AND AROUND THE RETORT AREA. MOST SOIL SAMPLES ANALYZED FOR TOTAL CHROMIUM AND HEXAVALENT CHROMIUM HAVE INDICATED THAT TRIVALENT CHROMIUM COMPOUNDS ARE PREVALENT IN THE NEAR-SURFACE SOILS.

HYDROGEOLOGIC STUDIES HAVE DEMONSTRATED THAT THE SITE IS UNDERLAIN BY FOUR HYDROSTRATIGRAPHIC ZONES. THE UPPER ZONE (ZONE 1) CONSISTS OF SILTY CLAY AND CLAYEY SILT, WITH MORE PERMEABLE STRINGERS AND LENSES OF SAND AND GRAVEL, TO A DEPTH OF ABOUT 20 FEET. THIS ZONE IS SEPARATED FROM A MORE PERMEABLE SAND AND GRAVEL LAYER (ZONE 2) BY A BLUE CLAY. ZONE 3 IS A CLAYEY SILT STRATUM, AND ZONE 4 CONSISTS OF CLAYEY SAND AND GRAVEL. ZONE 1 IS THE PRIMARY ZONE OF CONCERN BECAUSE OF THE PRESENCE OF CHROMIUM IN GROUND WATER. THE DEPTH TO GROUND WATER VARIES FROM 5 TO 10 FEET AND GROUND WATER GENERALLY FLOWS TO THE SOUTHEAST.

GROUND WATER QUALITY DATA SHOW THAT CHROMIUM CONCENTRATIONS ARE HIGHER NEAR THE RETORT AREA AND DECREASE IN THE DOWNGRADIENT DIRECTION. IN THE LAST THREE YEARS, MOST OFF-SITE WELLS HAVE NOT EXHIBITED CHROMIUM CONCENTRATIONS IN EXCESS OF THE DRINKING WATER STANDARD (0.05 MG/L). MOST STORM WATER QUALITY MONITORING DATA INDICATE THAT CHROMIUM CONCENTRATIONS ARE GENERALLY NEAR OR BELOW DETECTION LIMITS.

GEOCHEMICAL TESTS HAVE BEEN PERFORMED TO EVALUATE THE SORPTION AND DESORPTION CHARACTERISTICS OF CHROMIUM AND ARSENIC IN SOIL AND GROUND WATER. SORPTION TESTS HAVE SHOWN THAT ZONE 1 MATERIAL IS CAPABLE OF ADSORBING HEXAVALENT CHROMIUM TO THE EXTENT THAT CHROMIUM MIGRATION IS AT LEAST 5 TIMES SLOWER THAN GROUND WATER FLOW. DESORPTION TESTS HAVE INDICATED THAT A REDUCTION IN CHROMIUM CONCENTRATION CAN BE ACHIEVED BY GROUND WATER EXTRACTION. THE GEOCHEMICAL DATA HAVE BEEN USED TO ESTIMATE THE TIME OF AQUIFER CLEANUP. THE ABSENCE OF DISSOLVED ARSENIC IN GROUND WATER MONITORING WELLS INDICATES HIGH ADSORPTION CAPACITY FOR ARSENIC COMPOUNDS.

POTENTIAL MIGRATION PATHWAYS THROUGH AIR, DIRECT EXPOSURE TO SOIL, SURFACE WATER, AND GROUND WATER HAVE BEEN ASSESSED. IT IS CONCLUDED THAT THE MOST PROBABLE MIGRATION PATHWAY IS VIA GROUND WATER FLOW. BECAUSE OF THE OVERALL SITE IMPROVEMENTS AND THE INTERIM REMEDIAL MEASURES IMPLEMENTED, HOWEVER, OFF-SITE MIGRATION IS UNLIKELY A TRANSPORT MODEL HAS BEEN UTILIZED TO ASSESS THE AREAL DISTRIBUTION OF CHROMIUM IN CASE OF OFF-SITE MIGRATION. CONSIDERING THE LOW POPULATION DENSITY DOWNGRADIENT OF THE FACILITY AND THE ABSENCE OF WATER-PRODUCING WELLS IN THE IMMEDIATE SITE VICINITY, THERE IS NO PRESENT POTENTIAL EXPOSURE THROUGH GROUND WATER. THEREFORE, THERE IS NO HEALTH RISK ASSOCIATED WITH THIS PATHWAY IF OFF-SITE MIGRATION IS PREVENTED.

2.3 INTERIM REMEDIAL MEASURES

SINCE THE INITIATION OF INVESTIGATIONS AT THE CWP SITE, A NUMBER OF REMEDIAL MEASURES HAVE BEEN IMPLEMENTED BY CWP. GENERAL FACILITY IMPROVEMENTS HAVE INCLUDED GRADING AND CONSTRUCTION OF BERMS TO PREVENT SURFACE RUNOFF FROM THE RETORT AND TREATED WOOD STORAGE AREA. SURFACE PAVING, AND CONSTRUCTION OF ROOFS OVER THE RETORT AREA. THESE IMPROVEMENTS HAVE SUBSTANTIALLY REDUCED THE POTENTIAL FOR SOIL, STORM WATER, AND GROUND WATER CONTAMINATION.

IN OCTOBER 1983, WITHOUT REGULATORY AGENCY APPROVAL AND/OR OVERSIGHT, CWP CONSTRUCTED A 300-FOOT LONG, SLURRY CUTOFF WALL ALONG THE EASTERN SITE BOUNDARY TO A DEPTH OF ABOUT 20 FEET. CHROMIUM-CONTAINING GROUND WATER IS PUMPED FROM AN EXTRACTION TRENCH LOCATED HYDRAULICALLY UPGRADIENT OF THE SLURRY WALL. THE TRENCH APPEARS TO BE CAPABLE OF INTERCEPTING AND HYDRAULICALLY CONTROLLING GROUND WATER IN ZONE 1. EXTRACTED WATER IS RECYCLED BACK INTO CWP OPERATIONS WHEN POSSIBLE. THE PRESENCE OF THE SLURRY CUTOFF WALL AND EXTRACTION FROM THE TRENCH HAVE BEEN EFFECTIVE IN REDUCING THE OFF SITE MIGRATION OF CHROMIUM.

2.4 REMEDIAL ACTION ALTERNATIVES

A FEASIBILITY STUDY HAS BEEN CONDUCTED TO SCREEN AND EVALUATE VIABLE REMEDIAL ACTION ALTERNATIVES. IN CONDUCTING THE FEASIBILITY STUDY, CONTAMINATED SOIL WAS CONSIDERED THE PRIMARY POTENTIAL SOURCE OF GROUND WATER CONTAMINATION. CONTAMINATED GROUND WATER WAS CONSIDERED THE PRINCIPAL POTENTIAL HAZARD TO HUMAN HEALTH AND THE ENVIRONMENT. IN EVALUATING THE ALTERNATIVES, SOIL AND GROUND WATER ELEMENTS WERE ADDRESSED SEPARATELY.

REMEDIATION OF CONTAMINATED SOILS WILL OCCUR AT THE TIME OF CLOSURE OF THE FACILITY, PROJECTED TO BE 30 YEARS. A TRUST FUND WILL BE ESTABLISHED (SECTION 9.0) TO FUND FUTURE REMEDIATION OF SOILS. THE POTENTIAL REMEDIAL OPTIONS CONSIDERED FOR CONTROL OF THE CONTAMINATED SOIL INCLUDED SOIL REMOVAL/OFF-SITE DISPOSAL, SOIL REMOVAL/ON-SITE TREATMENT, CONTAINMENT, IN-SITU TREATMENT, AND NO ACTION. TREATABILITY STUDIES WILL BE CONDUCTED PRIOR TO SELECTING THE FINAL SOILS REMEDY AT THE TIME OF CLOSURE OF THE FACILITY. IT IS ANTICIPATED THAT ON-SITE SOIL TREATMENT OPTIONS WILL INCREASE AS THIS TECHNOLOGY DEVELOPS OVER THE NEXT 5 TO 10 YEARS.

THE ALTERNATIVES CONSIDERED FOR CONTROL OF THE CHROMIUM PLUME INCLUDED PHYSICAL CONTAINMENT, IN-SITU TREATMENT, HYDRAULIC CONTROL, AND NO ACTION. BASED ON PROVEN TECHNOLOGICAL CONSIDERATIONS AND COST, HYDRAULIC CONTROL WAS SELECTED AS THE MOST COST-EFFECTIVE REMEDIAL MEASURE. THIS OPTION WAS EVALUATED FOR PLUME CONTROL NEAR THE RETORT AREA, NEAR THE SITE BOUNDARY, AND OFF SITE.

AS HYDRAULIC CONTROL REQUIRES PROPER HANDLING OF CONTAMINATED GROUND WATER, VARIOUS DISCHARGE OPTIONS WERE CONSIDERED. THE MOST COST-EFFECTIVE OPTIONS INCLUDE RECYCLING THE GROUND WATER INTO CWP OPERATIONS OR DISCHARGE OF TREATED WATER INTO THE SANITARY SEWER, VIABLE GROUND WATER TREATMENT OPTIONS INCLUDE ELECTROCHEMICAL PROCESSES, CHEMICAL REDUCTION/PRECIPITATION, ACTIVATED CARBON ADSORPTION, ION EXCHANGE, REVERSE OSMOSIS, AND ELECTRODIALYSIS. BASED ON AVAILABILITY, PROVEN TECHNOLOGICAL CONSIDERATIONS, AND COST-EFFECTIVENESS, THE ELECTROCHEMICAL PROCESS WAS SELECTED FOR GROUND WATER TREATMENT.

2.5 SELECTED REMEDIAL ACTION ALTERNATIVE

THE SELECTED REMEDIAL ACTION ALTERNATIVE INCLUDED THE FOLLOWING ELEMENTS:

- SURFACE RUNOFF MANAGEMENT.
- CONTROL AND REMEDIATION OF CONTAMINATED SOIL.
- PLUME CONTROL AND AQUIFER REMEDIATION.
- ELECTROCHEMICAL TREATMENT OF GROUND WATER.
- WATER RECYCLING/DISCHARGE TO UKIAH SEWAGE TREATMENT PLANT OR REINJECTION.
- MONITORING.

SURFACE RUNOFF WILL BE CONTROLLED TO PREVENT POTENTIALLY CONTAMINATED WATER ENTERING SURFACE WATER DRAINAGE FEATURES. THE SITE WILL BE INSPECTED PERIODICALLY AND SURFACE PAVING REPAIRED AS APPROPRIATE. STORM WATER MONITORING SHALL BE PERFORMED AND THE DATA EVALUATED ACCORDING TO RWQCB ORDER NO. 85-103.

CONTAMINATED SOILS WILL BE CONTROLLED BY PREVENTING SURFACE WATER INFILTRATION AND BY EXERCISING HYDRAULIC CONTROL OF THE PLUME. SURFACE PAVING WILL PREVENT THE SURFACE SOILS FROM ACTING AS A SOURCE OF GROUND WATER CONTAMINATION. CHROMIUM LEACHED FROM THE SOIL AS A RESULT OF GROUND WATER LEVEL FLUCTUATIONS WILL BE CONTROLLED HYDRAULICALLY IN THE RETORT AREA AND NEAR THE SITE BOUNDARY. HYDRAULIC CONTAINMENT WILL BE ACHIEVED BY A GROUND WATER EXTRACTION AND TREATMENT SYSTEM UTILIZING EXISTING EXTRACTION WELLS HL-7 AND CWP-18. THESE PROVISIONS WILL PREVENT DIRECT HUMAN EXPOSURE TO CONTAMINATED SOIL, ELIMINATE THE CONTRIBUTION OF INFILTRATING SURFACE WATER TO GROUND WATER CONTAMINATION, AND PREVENT OFF-SITE MIGRATION. AFTER SITE CLOSURE, THE CONTAMINATED SOILS WILL BE REMEDIATED BY ON-SITE TREATMENT, AS DISCUSSED IN THE PREVIOUS SECTION.

PLUME CONTROL AND AQUIFER REMEDIATION WILL BE PERFORMED BY GROUND WATER EXTRACTION NEAR THE

RETORT AREA AND AT THE SITE BOUNDARY. WELL CWP-18, LOCATED IN THE RETORT AREA, WILL BE PUMPED TO EXTRACT GROUND WATER CONTAINING ELEVATED CHROMIUM CONCENTRATIONS. ALTHOUGH THE YIELD OF THIS WELL IS SMALL AND CONTINUOUS PUMPING MAY NOT BE POSSIBLE, THE POTENTIAL IMPACT ON AQUIFER RESTORATION IS BELIEVED TO BE SIGNIFICANT.

AT THE SITE BOUNDARY, WELL HL-7 (INSTALLED IN THE EXTRACTION TRENCH) WILL BE PUMPED AT FLOW RATES RANGING FROM 5 TO 20 GPM. EXTRACTION FROM THE TRENCH WILL PRODUCE A ZONE OF INFLUENCE WHICH WILL CONTAIN THE CHROMIUM PLUME, PREVENT OFF-SITE MIGRATION, AND GRADUALLY RESTORE THE AQUIFER. CONSIDERING THE TOTAL ESTIMATED VOLUME OF CONTAMINATED FLUID, PORE VOLUME REDUCTION REQUIREMENTS, AND EXPECTED FLOW RATES, THE PROJECTED MINIMUM DURATION OF AQUIFER CLEANUP IS ABOUT SEVEN YEARS. HOWEVER, CONSIDERING THE NATURE OF THE ASSUMPTIONS AND UNCERTAINTIES ASSOCIATED WITH THIS ESTIMATED TIME OF AQUIFER CLEANUP, A CONSERVATIVE DURATION OF 20 YEARS IS PROJECTED FOR PROJECT MANAGEMENT AND BUDGETARY PURPOSES. PROVISION IS ALSO MADE TO EXTRACT WATER FROM WELL CWP-8, LOCATED ON THE DOWNGRADIENT SIDE OF THE SLURRY CUTOFF WALL. EXTRACTION FROM THIS WELL WILL CONTAIN ANY RESIDUAL CHROMIUM THAT MAY PASS THE BARRIER. CONTAINMENT OF CHROMIUM IN THIS LOCATION WILL PREVENT CONTAMINATION OF DOWNGRADIENT AREAS.

A CONTINGENCY PLAN HAS ALSO BEEN DEVELOPED FOR THE EXTRACTION OF GROUND WATER IN THE OFF-SITE AREA LOCATED NEAR MONITORING WELL AT-2. DEPENDING ON FUTURE CONCENTRATIONS DETECTED IN THE OFF-SITE WELLS, ADDITIONAL EXTRACTION WELLS MAY BE NECESSARY TO ENSURE HYDRAULIC CONTROL OF THE CONTAMINATED PLUME.

THE EXTRACTED WATER WILL BE RECYCLED INTO CWP OPERATIONS, TO THE EXTENT POSSIBLE, OR TREATED ELECTROCHEMICALLY AND DISCHARGED INTO THE SANITARY SEWER. IMPLEMENTATION OF THIS DISCHARGE OPTION WILL PROVIDE MAXIMUM FLEXIBILITY IN SELECTING EXTRACTION RATES FROM WELL HL-7, AND WILL INCREASE THE EFFECTIVENESS OF CLEANUP OPERATIONS. THE TREATMENT SYSTEM EFFLUENT CONCENTRATIONS WILL MEET THE REQUIREMENTS OF THE UKIAH SEWAGE TREATMENT PLANT.

AIR, STORM WATER, AND GROUND WATER QUALITY MONITORING SHALL BE PERFORMED ACCORDING TO GENERAL AND SITE-SPECIFIC PROTOCOLS. STORM WATER MONITORING SHALL BE PERFORMED AT THE LOCATIONS AND FREQUENCIES SPECIFIED BY RWQCB ORDER NO. 85-101. STORM WATER SAMPLES WILL BE ANALYZED FOR DISSOLVED TOTAL CHROMIUM AND ARSENIC.

GROUND WATER SHALL BE MONITORED IN ON-SITE AND OFF-SITE WELLS INSTALLED SPECIFICALLY FOR THE CWP PROJECT. GROUND WATER MONITORING INCLUDES WATER LEVEL MEASUREMENTS AND WATER QUALITY ANALYSES. THE GROUND WATER SAMPLES SHALL BE ANALYZED FOR DISSOLVED TOTAL CHROMIUM, AS SPECIFIED IN RWQCB REVISED MONITORING AND REPORTING PROGRAM NO.85-101, ISSUED IN MAY 1987, AND ANY SUBSEQUENT ORDER, AS APPROPRIATE. MONITORING LOCATIONS AND FREQUENCIES ARE SUBJECT TO CHANGE AS REMEDIATION PROCEEDS.

MONITORING SHALL BE PERFORMED ACCORDING TO THE PROCEDURES OUTLINED IN THE "GROUND WATER/STORM WATER MONITORING PROTOCOL" DATED AUGUST 1987, PREPARED SPECIFICALLY FOR THE CWP FACILITY. THE MONITORING DATA SHALL BE REVIEWED PERIODICALLY TO EVALUATE THE EFFECTIVENESS OF THE RAP, AND RECOMMENDATIONS AND MODIFICATIONS SHALL BE MADE AS APPROPRIATE. THE MONITORING DATA AND RESULTS OF THESE EVALUATIONS SHALL BE REPORTED TO THE RWQCB AS REQUIRED BY THE REVISED MONITORING AND REPORTING PROGRAM NO. 85-101.

2.6 ALLOCATION OF FINANCIAL RESPONSIBILITY

CWP HAS OWNED AND OPERATED THE UKIAH FACILITY SINCE 1971 AND WILL BE RESPONSIBLE FOR IMPLEMENTATION OF THE RAP. THE PROVISIONS FOR FINANCIAL ASSURANCE ARE PROVIDED IN SECTION 9.0 OF THIS REPORT.

#SD
3.0 SITE DESCRIPTION

THIS SECTION PROVIDES A SUMMARY OF BACKGROUND INFORMATION PERTINENT TO THE RAP, INCLUDING THE LOCATION, HISTORY, AND A PHYSICAL DESCRIPTION OF THE SITE. THE CONTENT AND FORMAT OF THIS SECTION ARE GENERALLY CONSISTENT WITH THE RAP GUIDELINES PROVIDED BY THE DHS (SEPTEMBER 1987).

#SLC
3.1 SITE LOCATION

THE CWP FACILITY IS LOCATED AT THE INTERSECTION OF PLANT ROAD AND TAYLOR DRIVE IN AN UNINCORPORATED AREA OF MENDOCINO COUNTY, ABOUT 3 MILES SOUTH OF UKIAH, CALIFORNIA. THE SITE LOCATION IS SHOWN IN FIGURE 1. THE SITE COVERS AN AREA OF APPROXIMATELY 8 ACRES AND IS LOCATED IN SECTION 22 OF TOWNSHIP 15 NORTH, RANGE 12 WEST, RELATIVE TO THE MOUNT DIABLO BASELINE AND MERIDIAN. FOR THE PURPOSE OF THIS RAP, THE "SITE" REFERS TO THE AREA BOUNDED BY US HIGHWAY 101 TO THE WEST, PLANT ROAD TO THE NORTH, TAYLOR DRIVE TO THE EAST, AND AN UNPAVED TRACK TO THE SOUTH. THE "STUDY AREA" REFERS TO THE AREA BOUNDED BY PLANT ROAD AND THE UKIAH SEWAGE DISPOSAL FACILITY TO THE NORTH, THE RUSSIAN RIVER TO THE EAST, ROBINSON CREEK TO THE SOUTH, AND US HIGHWAY 101 TO THE WEST. THE STUDY AREA IS DELINEATED IN FIGURE 1. THE SITE AND VICINITY IS SHOWN IN FIGURE 2.

#SH

3.2 SITE HISTORY

THIS SECTION INCLUDES A BRIEF DESCRIPTION OF WOOD PRESERVING OPERATIONS AT THE SITE; THE TYPE OF CHEMICALS HANDLED; AND A CHRONOLOGY OF SITE CONTAMINATION, INVESTIGATION, AND INTERIM REMEDIAL MEASURES.

3.2.1 WOOD PRESERVING OPERATIONS

CWP BEGAN WOOD PRESERVING OPERATIONS AT THE SITE IN 1971 AND THE FACILITY HAS OPERATED CONTINUOUSLY UP TO THE PRESENT DATE. IT IS BELIEVED THAT PRIOR TO 1971, THE LAND WAS USED FOR AGRICULTURAL PURPOSES. THE WOOD PRESERVING OPERATIONS AND FACILITIES HAKE BEEN PERIODICALLY UPGRADED SINCE 1971 BY IMPLEMENTING SURFACE RUNOFF CONTROL MEASURES, SURFACE PAVING, CONSTRUCTION OF CANOPIES OVER WOOD TREATMENT AREAS, AND THE DEVELOPMENT OF TREATED WOOD STORAGE AND HANDLING PROCEDURES.

THE WOOD PRESERVING OPERATION AT THE SITE INVOLVES THE USE OF A CHEMICAL MIX CONSISTING OF 65.5 PERCENT SODIUM DICHROMATE, 18.3 PERCENT COPPER SULFATE, AND 16.4 PERCENT ARSENIC ACID. A DILUTE SOLUTION OF THE CHEMICAL MIX, CONTAINING THE EQUIVALENT OF 1.5 PERCENT BY WEIGHT OF CRO3, CUO, AND AS2O5, IS USED TO BATHE THE LUMBER IN PRESSURIZED RETORT CHAMBERS. AFTER EACH TREATMENT, THE RETORT CHAMBERS ARE DRAINED AND THE PRESERVING SOLUTION IS RECYCLED INTO THE WORKING SOLUTION TANK. RESIDUAL SOLUTION DRAINING FROM THE RETORT CHAMBERS AND DRIPPINGS FROM THE FRESHLY TREATED WOOD ARE COLLECTED IN CONCRETE-LINED SUMPS AND ARE ALSO RECYCLED INTO THE CHEMICAL MIX TANK VIA TEMPORARY HOLDING TANKS. THE SOLUTION TRANSFER TAKES PLACE THROUGH ABOVE-GROUND PVC PIPES. A PLAN OF THE SITE, INCLUDING THE FACILITIES MENTIONED ABOVE, IS SHOWN IN FIGURE 2.

3.2.2 CHEMICAL RELEASES

CONCERNS REGARDING THE POSSIBLE RELEASE OF WOOD PRESERVING CHEMICALS FROM THE CWP SITE WERE RAISED BY THE COUNTY OF MENDOCINO, THE DEPARTMENT OF FISH AND GAME, AND THE RWQCB IN EARLY 1972. A CHRONOLOGY OF THE SUBSEQUENT INTERACTION BETWEEN THE REGULATORY AGENCIES AND CWP IS PRESENTED IN APPENDIX A. THE CUMULATIVE DRIPPINGS FROM TREATED WOOD OVER THE YEARS ARE BELIEVED TO HAVE RESULTED IN NEAR-SURFACE SOIL CONTAMINATION AT THE SITE, PARTICULARLY DURING THE EARLY YEARS OF OPERATION WHEN THE TREATMENT AND TREATED WOOD STORAGE AREAS WERE NOT ALL PAVED. CURRENTLY, ALL BUT THE SOUTH AND SOUTHEAST PORTIONS OF THE SITE (AS SHOWN IN FIGURE 2) ARE PAVED WITH ASPHALT OR CONCRETE.

3.2.3 PREVIOUS STUDIES

AS INDICATED IN SECTION 3.2.2, THE RWQCB FIRST BECAME INVOLVED IN THE ENVIRONMENTAL ASPECTS OF CWP'S WOOD PRESERVING OPERATIONS IN EARLY 1972. THE RWQCB'S SPECIFIC CONCERNS WERE RELATED TO POTENTIAL SURFACE WATER AND GROUND WATER CONTAMINATION. APPENDIX A PROVIDES A CHRONOLOGY OF EVENTS RELATED TO ENVIRONMENTAL ACTIVITIES AT THE SITE.

ON JUNE 13, 1980, RWQCB STAFF COLLECTED SAMPLES OF SURFACE WATER RUNOFF WHICH WERE FOUND TO CONTAIN WOOD PRESERVING CHEMICALS. IN SEPTEMBER 1980, THE RWQCB REQUESTED THAT CWP ASSESS AND REPORT THE POSSIBLE IMPACT OF WOOD PRESERVING OPERATIONS ON SOIL AND GROUND WATER QUALITY BENEATH THE SITE. THIS ASSESSMENT, PERFORMED BY H. ESMAILI & ASSOCIATES, INC. (AUGUST 1981) AND REFERRED TO AS THE PHASE I STUDY, INCLUDED THE INSTALLATION OF SIX SHALLOW GROUND WATER MONITORING WELLS (WELLS CWP-1 THROUGH CWP-6). THE LOCATIONS OF THESE MONITORING WELLS ARE SHOWN IN FIGURE 2 AND THE CONSTRUCTION DETAILS ARE SUMMARIZED IN TABLE 1. THE INVESTIGATION INDICATED

ELEVATED CHROMIUM CONCENTRATIONS IN NEAR-SURFACE SOIL SAMPLES AND GROUND WATER SAMPLES COLLECTED FROM WELLS CWP-1 THROUGH CWP-6. NO ABNORMAL CONCENTRATIONS OF ARSENIC OR COPPER WERE FOUND IN ANY OF THE GROUND WATER SAMPLES.

IN OCTOBER 1981, CWP INSTALLED WELLS CWP-7, CWP-8, AND CWP-9 ALONG THE EASTERN SITE BOUNDARY TO EVALUATE POSSIBLE OFF-SITE MIGRATION. IN DECEMBER 1981, THE RWQCB INSTALLED OFF-SITE MONITORING WELLS FPT-1A, FPT-1B, FPT-2A, AND FPT-3 TO THE EAST OF THE SITE. THE ANALYSIS OF GROUND WATER SAMPLES FROM THESE WELLS CONFIRMED THAT OFF-SITE MIGRATION OF CHROMIUM HAD OCCURRED.

ADDITIONAL STUDIES WERE SUBSEQUENTLY INITIATED TO DETERMINE THE EXTENT OF GROUND WATER CONTAMINATION AND EVALUATE THE FEASIBILITY OF CONTAINING CONTAMINATED GROUNDWATER ON SITE. THIS PHASE II STUDY, CONDUCTED BY J. H. KLEINFELDER & ASSOCIATES (NOVEMBER 1982), INCLUDED THE INSTALLATION OF SEVEN ADDITIONAL ON-SITE GROUND WATER MONITORING WELLS (CWP-10 THROUGH CWP-16) AND SHOWED THAT THE VERTICAL EXTENT OF CHROMIUM, COPPER, AND ARSENIC IN SOIL AND GROUND WATER WAS LIMITED. THE LOCATIONS OF THE GROUND WATER MONITORING WELLS INSTALLED DURING THE PHASE I AND PHASE II STUDIES ARE SHOWN IN FIGURE 2. ADDITIONAL OFF-SITE GROUND WATER MONITORING WELLS (WELLS AT-1, AT-2, AT-3, FPT-4, AND FPT-5) WERE SUBSEQUENTLY INSTALLED BY KLEINFELDER AND CWP TO FURTHER DELINEATE OFF-SITE CONTAMINATION.

IN OCTOBER 1983, ACTING ON ITS OWN INITIATIVE BUT WITHOUT REGULATORY AGENCY APPROVAL OR OVERSIGHT, CWP CONSTRUCTED A BENTONITE SLURRY CUTOFF WALL, NEAR THE EASTERN SITE BOUNDARY, TO INTERCEPT AND LIMIT THE MIGRATION OF CHROMIUM INTO GROUND WATER. CWP ALSO CONSTRUCTED A GROUND WATER EXTRACTION TRENCH IMMEDIATELY TO THE WEST AND HYDRAULICALLY UPGRADIENT OF THE SLURRY CUTOFF WALL. THE APPROXIMATE LOCATIONS OF THE SLURRY CUTOFF WALL AND THE EXTRACTION TRENCH ARE SHOWN IN FIGURE 2. AS AN INTERIM REMEDIAL MEASURE, CWP BEGAN EXTRACTING GROUND WATER FROM THE TRENCH VIA A CENTRAL SUMP, KNOWN AS WELL HL-7, EQUIPPED WITH AN ELECTRIC SUBMERSIBLE PUMP. THE EXTRACTED GROUND WATER WAS RECYCLED BACK INTO THE WOOD PRESERVING OPERATION. ALSO, AS PART OF THE OVERALL EFFORT TO IMPROVE SITE CONDITIONS, CWP ERECTED CANOPIES OVER THE RETORT AREA. THESE COVERS LIMIT THE EXPOSURE OF FRESHLY TREATED WOOD TO PRECIPITATION AND REDUCE SURFACE WATER RUNOFF FROM THIS AREA. THESE INTERIM REMEDIAL MEASURES ARE DESCRIBED IN MORE DETAIL IN SECTION 5.0.

AFTER REVIEWING THE FINDINGS OF PHASES I AND II OF THE INVESTIGATION, THE REGULATORY AGENCIES REQUESTED THAT CWP FURTHER DEFINE THE DISTRIBUTION OF CHROMIUM, ARSENIC, AND COPPER IN SOIL AND GROUND WATER. (D'APPOLONIA) CONSULTING ENGINEERS, INC. (D'APPOLONIA) WAS RETAINED BY CWP TO PERFORM THIS INVESTIGATION AND ADDRESS THE AGENCIES' CONCERNS. THE INVESTIGATION INCLUDED A SERIES OF SOIL SAMPLING BORINGS, BORINGS S-1 THROUGH S-26 (D'APPOLONIA/IT CORPORATION, MAY 1984)(1), THE LOCATIONS OF WHICH ARE SHOWN IN FIGURE 2. THE INVESTIGATION SHOWED THAT THE TOP 1 TO 2 FEET OF THE SOIL PROFILE AROUND THE RETORT AND RAIL LINE AREAS CONTAINED ELEVATED CONCENTRATIONS OF CHROMIUM AND ARSENIC. IT IS NOTED, HOWEVER, THAT NO SOIL SAMPLES WERE COLLECTED FROM BENEATH THE ACTUAL RETORTS. THE GROUND WATER QUALITY DATA INDICATED ELEVATED CONCENTRATIONS OF CHROMIUM IN MONITORING WELLS LOCATED NEAR THE RETORT AREAS. CHROMIUM CONCENTRATIONS IN GROUND WATER GENERALLY DECREASED WITH DISTANCE FROM THE RETORT AREA IN THE DOWNGRADIENT DIRECTION.

SUBSEQUENT TO REGULATORY AGENCY REVIEW OF THE FINDINGS OF THE D'APPOLONIA INVESTIGATION, ANOTHER STUDY WAS INITIATED TO FURTHER DEFINE THE EXTENT AND MIGRATION BEHAVIOR OF CHROMIUM IN GROUNDWATER AND EVALUATE VIABLE REMEDIAL ACTION ALTERNATIVES TO ADDRESS CONTAMINATED SOIL AND GROUND WATER. THIS INVESTIGATION (IT CORPORATION, JUNE 1985) LED TO THE FOLLOWING CONCLUSIONS:

- CONTAINMENT OF CONTAMINATED SOIL AND REMEDIATION OF THE CONTAMINATED WATER-BEARING ZONE BY HYDRAULIC CONTROL MEASURES, SUCH AS GROUND WATER EXTRACTION, WAS FEASIBLE.

- THE MAJORITY OF THE EXTRACTED GROUND WATER COULD BE REUSED IN CWP'S WOOD PRESERVING OPERATIONS AND THE EXCESS COULD BE TREATED COST-EFFECTIVELY BY THE EXISTING ELECTROCHEMICAL UNIT AT THE SITE.

SUBSEQUENT TO THIS INVESTIGATION, A LARGE-DIAMETER EXTRACTION WELL, WELL CWP-18, WAS INSTALLED NEAR THE RETORT AREA TO CONTAIN CONTAMINATED GROUND WATER TO THE EXTENT POSSIBLE. ALSO, AN INJECTION WELL, WELL CWP-19, WAS INSTALLED HYDRAULICALLY UPGRADIENT OF THE RETORT AREA AND THE EXISTING CHROMIUM PLUME SO THAT EXCESS TREATED WATER COULD BE INJECTED BACK INTO THE WATER-BEARING ZONE. THE RETORT AREA EXTRACTION WELL AND THE UPGRADIENT INJECTION WELL ARE DESCRIBED FURTHER IN SECTION 5.0.

IN RESPONSE TO CONCERNS EXPRESSED BY THE REGULATORY AGENCIES REGARDING THE EFFECTIVENESS OF THE EXTRACTION TRENCH AND THE SLURRY CUTOFF WALL IN REMEDIATING AND CONTAINING THE CHROMIUM PLUME NEAR THE EASTERN SITE BOUNDARY, GEOSYSTEM PERFORMED A NUMBER OF INVESTIGATIONS TO EVALUATE AQUIFER PARAMETERS, ASSESS THE LEACHING BEHAVIOR OF SOILS, AND ESTIMATE THE DURATION OF AQUIFER CLEANUP (GEOSYSTEM, MARCH 1986; NOVEMBER 1986). A NUMBER OF ADDITIONAL ONSITE AND OFF-SITE MONITORING WELLS (WELLS CWP-22, AT-4, AND AT-5) WERE ALSO INSTALLED TO INVESTIGATE GROUND WATER QUALITY' HYDRAULICALLY DOWNGRADIENT OF THE SLURRY CUTOFF WALL. THE LOCATIONS OF THE ON-SITE AND OFF-SITE GROUND WATER MONITORING WELLS ARE SHOWN IN FIGURE 2, AND THE WELL CONSTRUCTION DETAILS ARE SUMMARIZED IN TABLE 1.

IN ADDITION TO THE STUDIES PERFORMED BY THEIR CONSULTANTS, CWP CONDUCTED REGULAR GROUND WATER MONITORING USING THEIR OWN RESOURCES. THE GROUND WATER MONITORING PROGRAM WAS ORIGINALLY SPECIFIED BY THE RWQCB IN ORDER NO. 83-93, WHICH WAS ADOPTED IN JUNE 1983. ORDER NO. 83-93 HAS BEEN REVISED AND/OR SUPERSEDED SEVERAL TIMES AS ADDITIONAL MONITORING WELLS HAVE BEEN INSTALLED AND EXISTING WELLS ABANDONED OR DELETED FROM THE MONITORING PROGRAM. THE CURRENT MONITORING PROGRAM IS IN ACCORDANCE WITH THE REQUIREMENTS OF THE MOST RECENT REVISION OF THE RWQCB ORDER (MAY 1987). MONITORING INCLUDES THE COLLECTION AND ANALYSIS OF STORM WATER SAMPLES FOR CHROMIUM AND ARSENIC. THE MONITORING PROGRAM ALSO INCLUDES GROUND WATER LEVEL MEASUREMENT AND THE COLLECTION AND ANALYSIS GROUNDWATER SAMPLES FOR DISSOLVED TOTAL CHROMIUM. GROUND WATER MONITORING IS PERFORMED ACCORDING TO THE GROUND WATER MONITORING PROTOCOL (GEOSYSTEM, AUGUST 3987) PREPARED SPECIFICALLY FOR THE CWP PROJECT.

THE WATER LEVEL MEASUREMENT AND GROUND WATER QUALITY DATA OBTAINED BY CWP, CONSULTANTS ACTING ON BEHALF OF CWP, AND REGULATORY AGENCY PERSONNEL HAVE BEEN COMPILED BY GEOSYSTEM ON A COMPUTER-BASED DATA MANAGEMENT SYSTEM. A SUMMARY OF THESE DATA IS PRESENTED IN APPENDIX B. A SUMMARY OF THE STORM WATER QUALITY DATA IS PRESENTED IN APPENDIX C, AND A SUMMARY OF THE SOIL QUALITY ANALYSES PERFORMED IS PRESENTED IN APPENDIX D.

BECAUSE OF THE LARGE VOLUME OF PREVIOUSLY REPORTED INVESTIGATIONS, THIS SUMMARY IS INTENDED TO PROVIDE ONLY A BRIEF INTRODUCTION TO THE CHARACTERIZATION STUDIES PERFORMED AT THE SITE. ADDITIONAL DETAILS AND INTERPRETATION OF THE FINDINGS OF THESE INVESTIGATIONS ARE PRESENTED IN SECTION 4.0 AND IN THE SUBJECT-SPECIFIC TECHNICAL REPORTS REFERENCED.

3.3 PHYSICAL DESCRIPTION

THIS SECTION INCLUDES DESCRIPTIONS OF TOPOGRAPHY, PHYSICAL SETTING, DEMOGRAPHY, CLIMATOLOGY, SENSITIVE STRUCTURES, AND POTENTIAL RECEPTORS.

3.3.1 TOPOGRAPHY

THE CWP SITE IS LOCATED IN THE UKIAH VALLEY. IN THE VICINITY OF THE SITE, THE VALLEY FLOOR IS ABOUT 2.5 MILES WIDE. THE VALLEY TAPERS TO AN UNNAMED, NARROW GORGE, SEVERAL HUNDRED FEET WIDE, AT A POINT ABOUT 4.5 MILES SOUTH OF THE SITE. THE RUSSIAN RIVER FLOWS SOUTH THROUGH THIS GORGE FROM THE UKIAH VALLEY INTO HOPLAND VALLEY. THE VALLEY FLOOR AT THE SITE IS AT AN ELEVATION OF ABOUT 565 TO 585 FEET ABOVE MEAN SEA LEVEL (MSL) AND SLOPES GENTLY TO THE SOUTH ALONG THE AXIS OF THE VALLEY, AT A GRADIENT OF ABOUT 0.2 PERCENT (1 IN 500).

THE UKIAH VALLEY IS BOUNDED BY STEEP MOUNTAINS TO THE EAST AND WEST. THOSE TO THE EAST OF THE SITE ARE KNOWN AS THE MAYACMAS MOUNTAINS AND RISE TO OVER 3,600 FEET ABOVE MSL. THE MOUNTAINS TO THE WEST INCLUDE CLELAND MOUNTAIN AND ELLEDGE PEAK WHICH RISE TO OVER 2,500 FEET ABOVE MSL. THE SLOPES OF THE MOUNTAINS BOUNDING THE UKIAH VALLEY RANGE FROM ABOUT 12 TO 67 PERCENT.

STEEP-SIDED VALLEYS, APPROXIMATELY PERPENDICULAR TO THE AXIS OF THE UKIAH VALLEY, ARE ALSO PROMINENT TOPOGRAPHIC FEATURES. THESE VALLEYS TYPICALLY CONTAIN TRIBUTARIES TO THE RUSSIAN RIVER. THE MOST SIGNIFICANT OF THESE WITH RESPECT TO THE CWP SITE IS THE VALLEY OCCUPIED BY ROBINSON CREEK, WHICH ENTERS THE UKIAH VALLEY FROM THE WEST, APPROXIMATELY 4,500 FEET SOUTH OF THE CWP SITE, AS SHOWN IN FIGURE 1.

THE TOPOGRAPHY OF THE CWP SITE ITSELF HAS BEEN LOCALLY ALTERED BY GRADING FOR DRAINAGE AND FOUNDATION PURPOSES. IN GENERAL, HOWEVER, THE LAND SURFACE SLOPES GENTLY TO THE EAST, TOWARDS TAYLOR DRIVE.

3.3.2 SITE FEATURES

IN TERMS OF SURFACE STRUCTURES, THE SITE FEATURES A GENERAL OFFICE IN THE NORTHWEST CORNER AND A GARAGE OR SERVICE-TYPE STRUCTURE NEAR THE CENTER OF THE SITE. THE TWO RETORTS IN WHICH LUMBER IS PRESSURE TREATED ARE ORIENTATED EAST-WEST NEAR THE WESTERN SITE BOUNDARY. EACH RETORT CHAMBER IS APPROXIMATELY 70 FEET LONG. THE RAIL LINES ASSOCIATED WITH EACH RETORT EXTEND ABOUT 140 FEET TO THE EAST. THE SUMP TO WHICH THE RETORTS DRAIN IS LOCATED AT THE EASTERN END OF THE VESSELS. THE WOOD PRESERVING SOLUTION IS RECYCLED TO, AND STORED IN, FOUR LARGE, ABOVE-GROUND TANKS ALONG THE WESTERN SITE BOUNDARY.

OTHER SIGNIFICANT SITE FEATURES INCLUDE A WALLED WORK TANK AREA IN WHICH WOOD PRESERVING SOLUTION IS MIXED. THIS WORK TANK AREA INCLUDES A LARGE CONCRETE SUMP CONTAINING "MAKE-UP" WATER. GROUND WATER EXTRACTED FROM WELLS HL-7 AND CWP-18 IS DISCHARGED TO THIS SUMP TO BE RECYCLED IN THE WOOD PRESERVING OPERATION. A LARGE, 330,000 GALLON, ABOVE-GROUND TANK IS USED TO STORE TREATED GROUND WATER.

THE MAJORITY OF THE SITE IS PAVED WITH ASPHALT CONCRETE AND IS USED FOR WOOD STORAGE. TREATED WOOD IS STORED IN THE NORTHEAST CORNER OF THE SITE. SURFACE RUNOFF FROM THIS AREA IS CONTROLLED BY ASPHALT BERMS AND COLLECTED IN A SUMP ON THE EASTERN SITE BOUNDARY, FROM WHICH IT IS RETURNED TO THE MAKE-UP WATER SUMP. THE UNPAVED AREAS OF THE SITE ARE LOCATED ALONG THE SOUTHEASTERN AND SOUTHERN SITE BOUNDARIES AND ARE GENERALLY VACANT OR USED FOR UNTREATED WOOD STORAGE.

THE CWP FACILITY IS FENCED FOR SECURITY AND IS ACCESSED VIA TWO SLIDING GATES WHICH ARE LOCKED OUTSIDE OF NORMAL BUSINESS HOURS OR USED FOR UNTREATED WOOD STORAGE.

3.3.3 SURROUNDING LAND USE

THE LARGE MAJORITY OF THE LAND SURFACE IN MENDOCINO COUNTY IS OCCUPIED BY NATIVE VEGETATION AND NON-IRRIGATED AGRICULTURE. A STUDY PERFORMED BY THE DEPARTMENT OF WATER RESOURCES (MAY 1980) PROJECTED LAND USE IN SEVERAL GROUND WATER BASINS ALONG THE RUSSIAN RIVER. IN 1974, NATIVE VEGETATION AND NON-IRRIGATED AGRICULTURE OCCUPIED OVER 185,000 ACRES IN THE UPPER RUSSIAN GROUND WATER BASIN, IN WHICH THE CWP SITE IS LOCATED. URBAN, IRRIGATED AGRICULTURE, AND RECREATIONAL LAND USE ACCOUNTED FOR APPROXIMATELY 3,400, 9,900, AND 250 ACRES, RESPECTIVELY. PROJECTIONS UP TO THE YEAR 2000 SUGGEST THAT URBAN AND IRRIGATED AGRICULTURAL LAND USE WILL INCREASE AT THE EXPENSE OF NATIVE VEGETATION AND NON-IRRIGATED AGRICULTURE. PROJECTED RECREATIONAL LAND USE REMAINS CONSTANT.

THE PRINCIPAL LAND USE IN MENDOCINO COUNTY IS FOR TIMBER PRODUCTION, WHICH PROVIDES TWO-THIRDS OF THE COUNTY'S AGRICULTURAL REVENUES. PASTURE AND RANGE LAND OCCUPIES 672,000 ACRES, WHILE FRUIT PRODUCTION, MOSTLY GRAPES AND PEARS, ACCOUNTS FOR 15,000 ACRES (COUNTY OF MENDOCINO, 1985). MAJOR LAND USES IN THE GENERAL VICINITY OF THE CWP SITE INCLUDE VINEYARDS, FRUIT AND NUT TREES, FORESTED LAND, SINGLE FAMILY RESIDENCES, AND TRANSPORTATION. LAND USE IN THE IMMEDIATE VICINITY OF THE CWP SITE INCLUDES TIMBER-RELATED FACILITIES, SEWAGE TREATMENT, FRUIT TREES (PEARS), TRANSPORTATION (US HIGHWAY 101), BUSINESS AND COMMERCIAL FACILITIES, AND VACANT LOTS. LAND USE WITHIN A 1.5 MILE RADIUS OF THE CWP SITE IS SHOWN IN FIGURE 3.

3.3.4 POPULATION DISTRIBUTION

IN 1986, THE POPULATION OF MENDOCINO COUNTY WAS 74,267, ABOUT 50 PERCENT OF WHICH RESIDED IN THE UKIAH AREA. THE POPULATION OF THE CITY OF UKIAH IN 1986 WAS 13,331 (GREATER UKIAH CHAMBER OF COMMERCE, JUNE 1987). OTHER, SMALLER COMMUNITIES IN THE VICINITY OF THE CWP SITE INCLUDE TALMAGE, LOCATED APPROXIMATELY 2 MILES TO THE NORTHEAST, AND HOPLAND, LOCATED APPROXIMATELY 10 MILES SOUTH ALONG US HIGHWAY 101.

THE MAIN POPULATION CENTER OF UKIAH IS APPROXIMATELY 3 MILES TO THE NORTH OF THE CWP SITE. IN THE VICINITY OF THE SITE, THERE ARE VERY FEW RESIDENCES. AERIAL PHOTOGRAPHS TAKEN IN APRIL 1984 INDICATE ONLY FIVE RESIDENTIAL STRUCTURES WITHIN A QUARTER-MILE RADIUS OF THE SITE BOUNDARIES. ACCORDING TO GREATER UKIAH CHAMBER OF COMMERCE RECORDS (JUNE 1987), THERE ARE AN AVERAGE OF 2.45 RESIDENTS PER DWELLING IN THE CITY OF UKIAH. USING THIS STATISTIC, IT APPEARS THAT THERE ARE LESS THAN 15 PEOPLE LIVING WITHIN A QUARTER-MILE OF THE CWP SITE.

INTERVIEWS CONDUCTED BY GEOSYSTEM PERSONNEL INDICATE THAT THERE ARE FOUR HOUSES, TWO DUPLEXES, TWO BUNK HOUSES, AND SIX MOTEL UNITS IN THE STUDY AREA WITHIN ONE-HALF MILE OF THE CWP SITE. IT IS NOTED THAT THE MOTEL UNITS ARE USED TO HOUSE SEASONAL WORKERS ASSOCIATED WITH THE ALEX THOMAS PEAR PACKING FACILITY. DURING THE WINTER MONTHS, ABOUT 20 PEOPLE MAY OCCUPY THESE RESIDENCES.

IN THE PEAK FRUIT HARVESTING SEASON, HOWEVER, THIS NUMBER MAY INCREASE TO ABOUT 100.

3.3.5 CLIMATOLOGY

THIS SECTION CHARACTERIZES THE CLIMATE IN THE VICINITY OF THE CWP SITE IN TERMS OF TEMPERATURE, PRECIPITATION, AND WIND SPEED AND DIRECTION. THE DATA HAVE BEEN OBTAINED FROM VARIOUS LOCATIONS IN AND AROUND UKIAH; HOWEVER, IT IS BELIEVED THAT THE VARIATIONS IN CLIMATE OVER THE RELATIVELY SMALL DISTANCES FROM THE CWP SITE ARE NOT SIGNIFICANT.

3.3.5.1 TEMPERATURE

UKIAH HAS A RELATIVELY MILD CLIMATE, CHARACTERIZED BY DRY, HOT SUMMERS AND COOL, WET WINTERS. BASED ON RECORDS AVAILABLE FROM 1877 TO 1980, THE AVERAGE AIR TEMPERATURE REPORTEDLY VARIES FROM 46.0 DEGREES FAHRENHEIT IN JANUARY TO 73.7 DEGREES FAHRENHEIT IN JULY, WITH AN AVERAGE ANNUAL AIR TEMPERATURE OF 59.2 DEGREES FAHRENHEIT. THE MAXIMUM AND MINIMUM TEMPERATURES RECORDED IN UKIAH SINCE RECORDS HAVE BEEN MAINTAINED WERE 114 AND 12 DEGREES FAHRENHEIT, RESPECTIVELY (FARRAR, JULY 1986). MEAN MONTHLY AIR TEMPERATURE DATA FOR UKIAH ARE PRESENTED IN TABLE 2.

3.3.5.2 PRECIPITATION

BASED ON RECORDS AVAILABLE FROM 1877 TO 1980, THE MEAN ANNUAL PRECIPITATION IN UKIAH IS 36.27 INCHES. THE RECORDS INDICATE, HOWEVER, THAT CONSIDERABLE VARIATION IN ANNUAL PRECIPITATION IS COMMON IN THE UKIAH AREA WITH VARIATIONS OF UP TO 30 INCHES OCCURRING IN CONSECUTIVE YEARS. THE MAXIMUM AND MINIMUM PRECIPITATION RECORDED DURING THE PERIOD OF RECORD WAS 60.97 AND 13.09 INCHES IN 1890 AND 1924, RESPECTIVELY (FARRAR, JULY 1986). ADDITIONAL PRECIPITATION DATA, REPORTEDLY COMPILED FROM US WEATHER BUREAU REPORTS AND UKIAH FIRE DEPARTMENT RECORDS, INDICATE THAT TOTAL PRECIPITATION WAS 70.19 INCHES IN THE 1982-1983 SEASON (SAVINGS BANK OF MENDOCINO COUNTY, 1987).

THE MAJORITY OF THE PRECIPITATION FALLS AS RAIN BETWEEN THE BEGINNING OF OCTOBER AND THE END OF APRIL, WITH MORE THAN 50 PERCENT OF THE ANNUAL RAINFALL OCCURRING IN DECEMBER, JANUARY, FEBRUARY. MEAN MONTHLY PRECIPITATION DATA, BASED ON RECORDS MAINTAINED FROM 1877 TO 1980, ARE SUMMARIZED IN TABLE 2. ON-SITE PRECIPITATION MEASUREMENTS HAVE ALSO BEEN RECORDED BY CWP PERSONNEL SINCE DECEMBER 1981. THESE DATA, SUMMARIZED IN TABLE 3, INDICATE THAT THE TOTAL ANNUAL PRECIPITATION HAS RANGED FROM A LOW OF 17.05 INCHES IN 1985 TO A HIGH OF 51.34 INCHES IN 1983. THESE DATA ARE CONSISTENT WITH MEASUREMENTS RECORDED ELSEWHERE IN THE UKIAH AREA AND ILLUSTRATE THE LARGE VARIATIONS IN ANNUAL PRECIPITATION MENTIONED ABOVE.

3.3.5.3

WIND DATA, RECORDED FROM 1950 TO 1964 AT TWO LOCATIONS AT THE UKIAH MUNICIPAL AIRPORT, INDICATE THAT THE MEAN ANNUAL WIND SPEED WAS 3.7 TO 3.9 MILES PER HOUR (MPH). WIND SPEEDS ARE GENERALLY HIGHER FROM APRIL TO JULY AND ARE LOWEST IN NOVEMBER AND DECEMBER. THE HIGHEST MEAN MONTHLY WIND SPEED RECORDED WAS 6.5 MPH IN JUNE 1959. THE LOWEST WAS 0.4 MPH IN DECEMBER 1963 (CALIFORNIA ENERGY COMMISSION, APRIL 1985).

THE PREVAILING WIND DIRECTION REPORTEDLY' NORTHWEST TO WEST (GREATER UKIAH CHAMBER OF COMMERCE, JUNE 1987). THE MEAN MONTHLY AND ANNUAL WIND SPEEDS FOR THE PERIOD OF RECORD ARE SUMMARIZED IN TABLE 2.

3.3.6 LOCATION OF WATER WELLS

A WELL INVENTORY WAS PERFORMED TO LOCATE WATER WELLS IN THE VICINITY OF THE CWP SITE AND TO DETERMINE THEIR STATUS. SOURCES OF INFORMATION INCLUDED PRIMARILY RECORDS MADE AVAILABLE BY THE DWR (JUNE 1956; OCTOBER 1986) AND WILLOW COUNTY WATER DISTRICT (WCWD). IN ADDITION, WELL LOGS AVAILABLE AT DWR IN SACRAMENTO, CALIFORNIA WERE REVIEWED AND THE LOCATIONS OF WELLS IN THE IMMEDIATE VICINITY OF THE CWP SITE WERE VERIFIED BY FIELD INSPECTION. THE WELL INVENTORY FOCUSED ON WELL LOCATIONS, WELL CONSTRUCTION DETAILS, STRATIGRAPHY, AND THE BENEFICIAL USES OF THE EXTRACTED WATER.

THE WELL INVENTORY INDICATED THE PRESENCE OF SEVERAL DOZEN WELLS IN THE VICINITY OF THE SITE. THE LOCATIONS OF THESE WELLS ARE SHOWN IN FIGURE 4. IT SHOULD BE NOTED THAT, WITH THE EXCEPTION OF THE RECORDS MAINTAINED BY WCUD, THE INFORMATION AVAILABLE ON WELL LOCATIONS AND CONSTRUCTION

DETAILS IS OFTEN VAGUE AND INCOMPLETE. FEW OF THE WELLS HAVE BEEN IDENTIFIED ACCORDING TO THE STATE WELL-NUMBERING SYSTEM AND THE INFORMATION REGARDING WELL LOCATIONS IS TYPICALLY IMPRECISE AND INSUFFICIENT TO LOCATE THE WELLS ACCURATELY. GEOSYSTEM HAS ATTEMPTED TO LOCATE WELLS AS ACCURATELY AS POSSIBLE, BASED ON THE AVAILABLE INFORMATION, AND IDENTIFY THE WELLS ACCORDING TO THE STATE WELL-NUMBERING SYSTEM. THE WELL LOCATIONS SHOWN IN FIGURE 4 MUST, HOWEVER, BE CONSIDERED APPROXIMATE. THE AVAILABLE WELL CONSTRUCTION DETAILS AND BENEFICIAL USES OF GROUND WATER ARE SUMMARIZED IN TABLE 4. IT IS NOTED THAT THE NEAREST WATER-PRODUCING WELL TO THE CWP SITE IS WELL 14N/12W-4D1, WHICH IS LOCATED ABOUT 1,000 FEET TO THE SOUTH.

ACCORDING TO INFORMATION OBTAINED BY GEOSYSTEM PERSONNEL, THIS WELL IS CAPPED AND NOT CURRENTLY ACTIVE. WELL 14N/12W-4E1, HOWEVER, APPEARS TO BE THE NEAREST WATER-PRODUCING WELL. ACCORDING TO THE OWNERS OF THE PROPERTY, THE WATER IS USED FOR DOMESTIC AND IRRIGATION PURPOSES. THIS WELL IS LOCATED ABOUT 1,500 FEET TO THE SOUTH OF THE CWP SITE.

3.3.7 POTENTIAL BIOLOGICAL RECEPTORS

POTENTIAL BIOLOGICAL RECEPTORS OF CONTAMINANTS ORIGINATING FROM THE CWP SITE ARE CONSIDERED TO INCLUDE NATIVE VEGETATION, FRUIT TREES, AQUATIC LIFE IN THE RUSSIAN RIVER AND ITS TRIBUTARIES, AND WILD ANIMALS AND BIRDS.

VEGETATION TYPES FOUND IN THE UPPER PORTION OF THE RUSSIAN RIVER WATERSHED INCLUDE HARDWOOD AND MIXED FOREST, CHAPARRAL, GRASSLAND, ORCHARDS AND VINEYARDS, AND RIPARIAN WOODLAND SPECIES. THE RIPARIAN WOODLAND SPECIES INCLUDE MULE FACT, SANDBAR WILLOW, RED WILLOW, AND FREMONT COTTONWOOD (MCBRIDE AND STRAHAN, 1981; JARA, 1974). IT IS NOTED THAT MOST OF THE LAND LOCATED IMMEDIATELY DOWNGRADIENT OF THE CWP SITE IS OCCUPIED BY PEAR ORCHARDS. THE SURFACE DRAINS AND CREEKS LOCATED DOWNSTREAM OF THE CWP FACILITY ARE SEASONALLY VEGETATED WITH TULLEYS, SOUR DOCK, ANISE, WILD ROSE, PEPPERMINT, AND CATTAILS.

THE RUSSIAN RIVER IS IMPORTANT AS A SPAWNING GROUND FOR ANADROMOUS FISH, OF WHICH THE PRINCIPAL VARIETIES ARE STEELHEAD TROUT AND SILVER (OR COHO) SALMON. OTHER FISH INHABITING THE BASIN INCLUDE KING (OR CHINOOK) SALMON, SMALL-MOUTH BASS, AMERICAN SHAD, STRIPED BASS, AND WHITE CATFISH.

THE RUSSIAN RIVER BASIN SUPPORTS A WIDE RANGE OF WILDLIFE SPECIES, INCLUDING A SUBSTANTIAL POPULATION OF BLACKTAILED DEER, BANDTAILED PIGEONS, AND PHEASANTS. SEVERAL SPECIES OF SMALL MAMMALS ASSOCIATED WITH AGRICULTURAL LAND USE, I.E. RATS, MICE, AND RABBITS, ARE ALSO FOUND IN THE AREA. THE RUSSIAN RIVER BASIN SUPPORTS A VARIETY OF RESIDENT AND NON-RESIDENT WATERFOWL WHICH UTILIZE THE RIVER HABITAT FOR NESTING AND REFUGE (US ARMY CORPS OF ENGINEERS, MARCH 1982).

#**SRF**

4.0 SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

THIS SECTION SUMMARIZES THE GEOLOGIC, HYDROLOGIC, AND SOIL/GROUND WATER QUALITY DATA GENERATED DURING THE REMEDIAL INVESTIGATIONS. DETAILS OF THE REMEDIAL INVESTIGATIONS HAVE BEEN SUBMITTED IN A NUMBER OF PREVIOUS TECHNICAL REPORTS, WHICH ARE REFERENCED AS APPROPRIATE. THE CONTENT AND FORMAT OF THE SUMMARY OF REMEDIAL INVESTIGATION FINDINGS IS IN GENERAL CONFORMANCE WITH THE RAP GUIDELINES (DHS, SEPTEMBER 1987).

4.1 GEOLOGY

THE DISCUSSION OF REGIONAL GEOLOGY AND STUDY AREA STRATIGRAPHY IS BASED PRIMARILY ON PUBLISHED WATER SUPPLY PAPERS/GEOLOGIC REPORTS BY GOVERNMENT AGENCIES, SITE-SPECIFIC REPORTS PREPARED BY CWP'S CONSULTANTS, AND DISCUSSIONS WITH REGULATORY AGENCY PROJECT PERSONNEL. THE DISCUSSION IS INTENDED TO HELP INTERPRET THE STRATIGRAPHY ENCOUNTERED AT THE SITE IN THE CONTEXT OF THE OVERALL, REGIONAL GEOLOGY AND TO IDENTIFY AND CHARACTERIZE THE GEOLOGIC UNITS PERTINENT TO THE CWP PROJECT. THE PRIMARY REFERENCE FOR REGIONAL GEOLOGY IS A US GEOLOGICAL SURVEY (USGS) REPORT ENTITLED "GROUND WATER RESOURCES IN MENDOCINO COUNTY, CALIFORNIA" (FARRAR, JULY 1986). OTHER SOURCES OF INFORMATION ARE REFERENCED AS APPROPRIATE.

4.1.1 REGIONAL GEOLOGY

MENDOCINO COUNTY IS LOCATED LARGELY WITHIN THAT PART OF THE COAST RANGES GEOMORPHIC PROVINCE KNOWN AS THE MENDOCINO RANGE. THE MENDOCINO RANGE IS CHARACTERIZED BY ROCKS OF THE FRANCISCAN

COMPLEX. THE GEOLOGIC UNITS EXPOSED AT THE SURFACE IN THE UKIAH VALLEY MAY BE CATEGORIZED AS BASEMENT ROCKS OR VALLEY FILL.

BASEMENT ROCKS ARE CONSIDERED TO INCLUDE ALL PRE-PLIOCENE FORMATIONS. ABOUT 95 PERCENT OF THE SURFACE EXPOSURES CONSIST OF BASEMENT ROCKS OF THE FRANCISCAN COMPLEX. IN THE VICINITY OF THE SITE, THE FRANCISCAN COMPLEX HAS BEEN DIVIDED INTO THE COASTAL BELT AND THE CENTRAL BELT BASED ON LITHOLOGIC AND STRUCTURAL DIFFERENCES. THE DIVISION BETWEEN THE TWO IS LOCATED ALONG THE AXIS OF THE UKIAH VALLEY, WITH THE COASTAL BELT FORMING THE MOUNTAINS THAT BOUND THE VALLEY TO THE WEST, AND THE CENTRAL BELT FORMING THE MAYACMAS MOUNTAINS TO THE EAST. VALLEY FILL REFERS TO GEOLOGIC UNITS OF QUATERNARY AGE OR THOSE THAT SPAN LATE TERTIARY AND QUATERNARY AGE. VALLEY FILL DEPOSITS ARE CONFINED TO SEVERAL SMALL BASINS ALONG MAJOR SURFACE DRAINAGE FEATURES AND THE THIN ALLUVIUM IN STREAM CHANNELS.

PHYSIOGRAPHICALLY, THE SITE IS LOCATED IN THE UKIAH VALLEY, A NORTH-SOUTH TRENDING ALLUVIAL BASIN FORMED BY THE RUSSIAN RIVER AND ITS TRIBUTARIES. THE VALLEY FILL WITHIN THE UKIAH VALLEY HAS BEEN SUBDIVIDED BY FARRAR (JULY 1986) INTO THREE DISTINCT UNITS: CONTINENTAL BASIN DEPOSITS; CONTINENTAL TERRACE DEPOSITS; AND HOLOCENE ALLUVIUM. THE DISTINCTION IS MADE ACCORDING TO THE AGE AND ORIGIN OF THE MATERIALS, ALTHOUGH SEVERAL INVESTIGATORS (CARDWELL, 1965; FARRAR, JULY 1986) HAVE REPORTED DIFFICULTY IN DIFFERENTIATING BETWEEN THESE UNITS ON THE BASIS OF THE DESCRIPTIONS USUALLY AVAILABLE FROM WELL DRILLERS LOGS. THE AREAL DISTRIBUTION OF THE VALLEY FILL UNITS (CARDWELL, 1965; FARRAR, JULY 1986) IS SHOWN IN FIGURE 5. A SCHEMATIC SECTION THROUGH THE UKIAH VALLEY, ILLUSTRATING THE STRATIGRAPHIC RELATIONSHIP BETWEEN THE VALLEY FILL UNITS, IS SHOWN IN FIGURE 6.

BASED ON STRATIGRAPHIC INFORMATION OBTAINED FROM AVAILABLE WATER WELL LOGS, A REGIONAL GEOLOGIC CROSS-SECTION ALONG THE AXIS OF THE UKIAH VALLEY, PARALLEL TO THE DIRECTION OF GROUND WATER FLOW, HAS BEEN PREPARED. THE APPROXIMATE LOCATIONS OF THE WATER-PRODUCING WELLS, GROUND WATER CONTOURS, AND THE SECTION LINE ARE SHOWN IN FIGURE 4. THE REGIONAL GEOLOGIC CROSS-SECTION IS SHOWN IN FIGURE 7. EACH OF THE THREE VALLEY FILL UNITS REFERENCED ABOVE IS DESCRIBED BELOW AS THEY ARE BELIEVED TO BE THE GEOLOGIC UNITS COST RELEVANT TO THE CWP PROJECT.

4.1.1.1 CONTINENTAL BASIN DEPOSITS

THE CONTINENTAL BASIN DEPOSITS ARE OF PLIOCENE AND PLEISTOCENE AGE AND REPRESENT THE OLDEST OF THE VALLEY FILL UNITS. THE CONTINENTAL BASIN DEPOSITS WERE DEPOSITED UNCONFORMABLY OVER THE BASEMENT ROCKS OF THE FRANCISCAN COMPLEX BY LANDSLIDES AND DEBRIS FLOW FROM THE ADJACENT HIGHLANDS. SUBSEQUENT TO DEPOSITION, THE MATERIALS WERE REWORKED BY GRAVITY AND STREAM PROCESSES.

THE COMPLEX DEPOSITIONAL PROCESS RESULTED IN A HETEROGENEOUS MIXTURE OF LOOSELY CEMENTED GRAVEL, SAND, SILT, AND CLAY. THE PREDOMINANT MATERIAL IS CLAY WHICH OCCURS IN BEDS AND AS INTERSTITIAL MATERIAL BETWEEN COARSER GRAINS OF SAND AND GRAVEL. THE HIGH CLAY CONTENT AND POOR SORTING RESULT IN GENERALLY LOW PERMEABILITIES.

THE THICKNESS OF THE CONTINENTAL BASIN DEPOSITS RANGES FROM ZERO ALONG THE MARGINS OF THE UKIAH VALLEY TO AT LEAST 500 FEET NEAR ITS AXIS. NO OUTCROPS HAVE BEEN RECORDED ALONG THE WESTERN MARGIN OF THE UKIAH VALLEY NEAR THE SITE; HOWEVER, EXTENSIVE OUTCROPS DO OCCUR ALONG THE EASTERN SIDE. REPORTEDLY, THE CONTINENTAL BASIN DEPOSITS ARE LIKELY TO OCCUR AT DEPTH, BENEATH YOUNGER VALLEY FILL DEPOSITS, OVER MOST OF THE UKIAH VALLEY (FARRAR, JULY 1986).

4.1.1.2 CONTINENTAL TERRACE DEPOSITS

THE CONTINENTAL TERRACE DEPOSITS HAVE BEEN SUBDIVIDED (CARDWELL, 1965) INTO OLDER AND YOUNGER TERRACE DEPOSITS. YOUNGER TERRACE DEPOSITS HAVE BEEN MAPPED ALONG THE WESTERN MARGIN OF THE UKIAH VALLEY IN THE VICINITY OF THE SITE. MOST OF THE CITY OF UKIAH, NOTABLY THE DOWNTOWN AREA ALONG STATE STREET, HAS BEEN DEVELOPED ON YOUNGER TERRACE DEPOSITS. THE OCCURRENCE OF THE YOUNGER TERRACE DEPOSITS AT THE SURFACE ALONG THE WESTERN MARGIN OF THE UKIAH VALLEY IS DISCONTINUOUS WHERE ROBINSON CREEK EMERGES FROM THE ADJACENT HIGHLANDS. ALTHOUGH LITHOLOGICALLY VERY SIMILAR TO THE CONTINENTAL BASIN DEPOSITS, THE CLAY AND SILT CONTENT OF THE YOUNGER TERRACES IS GENERALLY LESS. AS IN THE CONTINENTAL BASIN DEPOSITS, VERTICAL AND LATERAL DISCONTINUITY OF INDIVIDUAL BEDS AND LENSES IS COMMON. THE UNIT IS GENERALLY CONSIDERED TO HAVE LOW PERMEABILITY.

THE MAXIMUM THICKNESS OF THE YOUNGER CONTINENTAL TERRACE DEPOSITS IS NOT ACCURATELY KNOWN, AS THEY ARE VERY DIFFICULT TO DIFFERENTIATE FROM THE UNDERLYING CONTINENTAL BASIN DEPOSITS.

4.1.1.3 HOLOCENE ALLUVIUM

THE HOLOCENE ALLUVIUM IS COMPOSED OF UNCEMENTED GRAVEL, SAND, SILT, AND CLAY. THE ALLUVIUM REPORTEDLY COVERS BROAD AREAS OF THE UKIAH VALLEY IN THE VICINITY OF THE SITE (CARDWELL, 1965; FARRAR, JULY 1986). THE ALLUVIUM ALSO EXTENDS INTO SEVERAL SMALLER VALLEYS ASSOCIATED WITH TRIBUTARIES TO THE RUSSIAN RIVER, MOST NOTABLY THE VALLEY ASSOCIATED WITH ROBINSON CREEK. WITHIN THE CENTRAL STRIP OF THE VALLEY, ALONG THE RUSSIAN RIVER, HIGHLY PERMEABLE, LOOSE GRAVEL AND COARSE SAND DEPOSITS HAVE BEEN DEVELOPED. THESE DEPOSITS ARE IN DIRECT HYDRAULIC COMMUNICATION WITH THE SURFACE WATER IN THE RUSSIAN RIVER.

THE THICKNESS OF THE HOLOCENE ALLUVIUM IS NOT ACCURATELY KNOWN, AGAIN BECAUSE DIFFERENTIATION BETWEEN THE HOLOCENE ALLUVIUM AND THE UNDERLYING CONTINENTAL BASIN DEPOSITS IS VERY DIFFICULT. AREAS OF HIGH POROSITY AND PERMEABILITY OCCUR DUE TO THE UNCEMENTED, COARSE-GRAINED NATURE OF LOCALIZED SEDIMENTS. THESE AREAS OF HIGH PERMEABILITY ARE TYPICALLY CLOSE TO THE PRESENT COURSE OF THE RUSSIAN RIVER.

4.1.2 STUDY AREA STRATIGRAPHY

PREVIOUS INVESTIGATIONS BY CONSULTANTS TO CWP (H. ESMAILI & ASSOCIATES, AUGUST 1981; J.H. KLEINFELDER AND ASSOCIATES, NOVEMBER 1982; D'APPOLONIA, MAY 1984; IT CORPORATION, JUNE 1985; GEOSYSTEM, JANUARY 1987) AND BY THE RWQCB HAVE INCLUDED THE INSTALLATION OF OVER 30 GROUND WATER MONITORING WELLS AND THE DRILLING OF NUMEROUS SOIL BORINGS IN THE STUDY AREA. BASED ON THE INFORMATION OBTAINED FROM THE ABOVE REFERENCED INVESTIGATIONS, ATTEMPTS HAVE BEEN MADE TO ASSESS THE STRATIGRAPHY ENCOUNTERED AT THE SITE IN THE CONTEXT OF THE REGIONAL GEOLOGY. CARDWELL (1965) HAS MAPPED THE CONTACT BETWEEN THE YOUNGER CONTINENTAL TERRACE DEPOSITS AND THE HOLOCENE ALLUVIUM AS BISECTING THE CWP SITE AS SHOWN IN FIGURE 5. BASED ON THE STRATIGRAPHIC INFORMATION AVAILABLE FROM THE MAJORITY OF THE BORINGS IN THE STUDY AREA, HOWEVER, IT HAS NOT BEEN POSSIBLE TO DIFFERENTIATE BETWEEN THESE UNITS. AS THE TERRACE DEPOSITS ARE TYPICALLY SLIGHTLY ELEVATED, IT IS POSSIBLE THAT CARDWELL ORIGINALLY MAPPED THE CONTACT BASED ON TOPOGRAPHIC RELIEF. IF SO, THE CONSTRUCTION OF US HIGHWAY 101 AND THE OVERALL DEVELOPMENT OF THE AREA APPEARS TO HAVE OBLITERATED ANY SUCH EVIDENCE OF THIS CONTACT.

BASED UPON A REVIEW OF THE STRATIGRAPHIC LOGS RECORDED DURING THE SITE CHARACTERIZATION STUDIES, IT APPEARS THAT THE MATERIALS ENCOUNTERED IN THE STUDY AREA GENERALLY CORRESPOND WITH THE CONTINENTAL BASIN AND TERRACE DEPOSITS. THE PRESENCE OF ELEVATED TERRACES AND THE INCISED NATURE OF THE RUSSIAN RIVER ARE INDICATIVE OF CHANGES IN STREAM LEVEL, PROBABLY AS A RESULT OF RECENT CONTINUED UPLIFT OF THE REGION. CONSEQUENTLY, EROSIONAL PROCESSES PREDOMINATE OVER DEPOSITIONAL PROCESSES AND THE MORE COARSE-GRAINED, HIGHLY PERMEABLE SEDIMENTS CHARACTERIZED AS HOLOCENE ALLUVIUM MAY BE LIMITED TO A NARROW STRIP ADJACENT TO THE RUSSIAN RIVER CHANNEL. THE RELATIVELY LARGE NUMBER OF SHALLOW, HIGH PRODUCTION WELLS IMMEDIATELY ADJACENT TO THE RUSSIAN RIVER SUPPORTS THIS GEOLOGIC CONCEPTUALIZATION.

THE STRATIGRAPHIC INFORMATION RECORDED ON THE AVAILABLE DRILLING LOGS HAS BEEN USED TO CONSTRUCT SUBSURFACE PROFILES A-A' AND B-B', WHICH ARE SHOWN IN FIGURES 8 AND 9, RESPECTIVELY. AS SHOWN IN THE SUBSURFACE PROFILES, THE STRATIGRAPHY IN THE SITE AREA IS CHARACTERIZED BY NUMEROUS AND ABRUPT LATERAL FACIES CHANGES. THESE CONDITIONS REFLECT A FLUVIAL ENVIRONMENT IN WHICH THE DEPOSITIONAL CONDITIONS WERE CONSTANTLY CHANGING, RANGING FROM A VERY LOW HYDRAULIC ENERGY (DEPOSITION OF SILT AND CLAY) TO HIGH ENERGY (DEPOSITION OF SAND AND GRAVEL). THE STRATIGRAPHY IS, THEREFORE, COMPLEX AND CORRELATION OF THE VARIOUS UNITS IS NOT SELF-EVIDENT. THERE ARE, HOWEVER, GENERAL LITHOLOGIC TRENDS WHICH ARE FUNCTIONAL IN TERMS OF THE HYDROLOGIC BEHAVIOR OF THE SEDIMENTS AND THE MIGRATION OF CHROMIUM. BASED ON THESE TRENDS, FOUR ZONES, ZONES 1 THROUGH 4, HAVE BEEN DEFINED UNDER THE SITE.

ZONE 1 IS THE UPPERMOST OF THE FOUR ZONES. THE STRATIGRAPHIC INFORMATION INDICATES THAT ZONE 1 IS CONTINUOUS THROUGHOUT THE SITE AND IMMEDIATE DOWNGRADIENT VICINITY. ZONE 1 HAS BEEN REWORKED AND GRADED DURING THE DEVELOPMENT OF THE CWP SITE AND THE CONSTRUCTION OF TAYLOR DRIVE AND SEVERAL SURFACE DRAINAGE FEATURES. THE LOWER BOUNDARY OF ZONE 1 IS DEFINED BY A BLUE, CLAYEY SILT/SILTY CLAY, GLEYED HORIZON. ZONE 1 IS UNDERLAIN IN SEQUENCE BY ZONES 2, 3, AND 4.

AS THE MAJORITY OF THE BORINGS DRILLED FOR SOIL SAMPLING AND MONITORING WALL INSTALLATION

PURPOSES WERE RELATIVELY SHALLOW, THE AREAL EXTENT OF ZONE 2 IS LESS WELL DEFINED. THE AVAILABLE INFORMATION, HOWEVER, INDICATES THAT ZONE 2 MAY BE CONTINUOUS FROM WELL CWP-17 ON SITE TO WELL AT-4 OFF SITE (FIGURES 2 AND 8).

LITTLE INFORMATION IS AVAILABLE REGARDING THE CONTINUITY AND AREAL EXTENT OF ZONE 3 AND 4; HOWEVER, IT IS NOTED THAT THEY ARE NOT OF PRIME IMPORTANCE RELATIVE TO THE POSSIBLE MIGRATION OF CHROMIUM IN GROUND WATER. EACH OF ZONES 1 THROUGH 4 IS DESCRIBED BELOW.

4.1.2.1 ZONE 1

ZONE 1 IS CONSIDERED TO EXTEND VERTICALLY FROM THE GROUND SURFACE TO A DEPTH OF APPROXIMATELY 20 FEET. ZONE 1 CONSISTS PRIMARILY OF SILTY CLAY, CLAYEY SILT, AND CLAYEY SAND, WITH MORE PERMEABLE STRINGERS AND LENSES OF SILTY SAND AND GRAVEL. THE SILTY CLAYS AND CLAYEY SILTS ARE GENERALLY STIFF TO VERY STIFF, LOW TO MODERATELY PLASTIC, AND LOCALLY CONTAIN CARBON GRANULES AND HEALED ROOT HOLES. THE COLORS OF THE SOILS IN ZONE 1 HAVE BEEN RECORDED AS YELLOW-BROWN TO MOTTLED GRAY AND BROWN. VARYING AMOUNTS OF VERY SOFT, DEEPLY WEATHERED FRAGMENTS OF SEDIMENTARY ROCKS (PREDOMINANTLY MUDSTONE) ARE PRESENT IN THE CLAY. BASED ON THE GENERALLY VARIEGATED APPEARANCE AND EMBEDDED ROCK FRAGMENTS IN A CLAY MATRIX, IT IS BELIEVED THAT THE CLAY HAS BED DEVELOPED IN SITU FROM THE YOUNGER TERRACE DEPOSITS. STRINGERS OF GRAVEL AND FINE SAND ARE PRESENT IN THE CLAY WHICH YIELD VARYING, BUT GENERALLY LIMITED, QUANTITIES OF WATER. AS SHOWN IN FIGURES 8 AND 9, THE LATERAL CONTINUITY OF THESE STRINGERS IS THOUGHT TO BE LIMITED AS CORRELATION FOR SIGNIFICANT DISTANCES DOES NOT APPEAR TO BE POSSIBLE.

ZONE 1 IS CONSIDERED TO BE THE ZONE MOST IMPACTED BY CHROMIUM COMPOUNDS. THE LATERAL MIGRATION THROUGH THIS ZONE APPEARS TO BE LIMITED TO THE IRREGULAR, MORE PERMEABLE SAND AND GRAVEL LENSES. THE OFF-SITE MIGRATION OF CHROMIUM IN THESE MORE PERMEABLE STRATA HAS BEEN RETARDED BY THE INSTALLATION OF THE SLURRY CUTOFF WALL AND GROUND WATER EXTRACTION FROM WELL HL-7. THE SLURRY CUTOFF WALL REPORTEDLY EXTENDS THROUGHOUT THE FULL DEPTH OF ZONE 1. THE VERTICAL MIGRATION THROUGH THE SOILS WITHIN ZONE 1 IS BELIEVED TO BE VERY SLOW BECAUSE OF THE APPARENT HETEROGENEITY AND DISCONTINUITY OF PERMEABLE LENSES.

THE LOWER BOUNDARY OF ZONE 1 IS CONSIDERED TO BE THE VERY STIFF, BLUE, GLEYED, CLAYEY SILT/SILTY CLAY LAYER WHICH IS TYPICALLY 4 TO 5 FEET THICK. THE GLEYED AND RELATIVELY UNIFORM QUALITY OF THIS STRATUM INDICATES A WELL-WEATHERED (OLDER) DEVELOPMENT AND LOW HYDRAULIC CONDUCTIVITY. AS SHOWN IN FIGURES 8 AND 9, THIS BLUE CLAY/SILT LAYER HAS BEEN INTERCEPTED BY NUMEROUS BORINGS AT THE SITE AND CORRELATES REASONABLY WELL FROM THE CENTER OF THE SITE AS FAR SOUTH AS BORING AT-5. THIS STRATUM IS LESS WELL DEFINED NEAR THE RETORTS; HOWEVER, IT IS NOTED THAT THE TOPOGRAPHY IN THIS AREA IS ELEVATED AND THE BORINGS ARE GENERALLY SHALLOWER. THE BLUE CLAY/SILT LAYER APPEARS TO LIMIT DOWNWARD MIGRATION OF CHROMIUM FROM ZONE 1 TO ZONE 2.

THE CORRELATION OF THIS STRATUM DEPENDS PRIMARILY ON ITS DISTINCTIVE BLUE COLORATION. THE APPARENT ABSENCE OF THIS BLUE CLAY/SILT LAYER IN SOME BORINGS (CWP-13 AND CWP-17) MAY BE ATTRIBUTABLE TO GEOLOGIC CONDITIONS AND/OR TO SAMPLING AND DESCRIPTIVE PROCEDURES, FOR EXAMPLE, AS SHOWN IN PROFILE A-A' (FIGURE 8), THE BLUE CLAY/SILT LAYER WAS ENCOUNTERED IN WELL CWP-22; FURTHER TO THE NORTH, HOWEVER, IN WELL CWP-13, THE FINEGRAINED SEDIMENTS HAVE BEEN REPLACED BY A SANDY FACIES. IT IS POSSIBLE THAT THE BLUE CLAY/SILT LAYER WAS DEPOSITED AND LATER ERODED AND REPLACED BY A CHANNEL-FILL, REPRESENTING A HIGHER ENERGY FACIES. ON THE OTHER HAND, THE OMISSION MAY BE DUE TO THE SAMPLING INTERVAL, AS COMPARED WITH THE THICKNESS OF THE LAYER.

4.1.2.2 ZONE 2

ZONE 2 CONSISTS OF A SAND AND GRAVEL LAYER WHICH VARIES FROM APPROXIMATELY 5 TO 10 FEET THICK. THE SANDS AND GRAVELS IN ZONE 2 GENERALLY CONTAIN APPRECIABLE AMOUNTS OF SILT AND CLAY, AND ARE DENSE AND SLIGHTLY CEMENTED IN SOME AREAS. MOST OF THE GRAVEL IS SUBANGULAR AND LESS THAN ONE-HALF INCH IN SIZE. STRINGERS OF POORLY GRADED FINE SAND AND MEDIUM COARSE SAND ARE ALSO PRESENT. IN BORING AT-4, A THIN LAYER OF SILT IS PRESENT WITHIN ZONE 2.

ZONE 2 IS BELIEVED TO BE THE MOST SIGNIFICANT WATER PRODUCER OF THE FOUR ZONES IN THE SITE AREA. AS SHOWN IN FIGURE 8, ZONE 2 CAN BE CORRELATED BETWEEN THE DEEP BORINGS FROM SOUTH OF THE RETORT AREA TO OFF-SITE AREAS. ZONE 2 APPEARS TO DECREASE IN THICKNESS TO THE SOUTHEAST AND WAS NOT ENCOUNTERED AT ALL IN BORING AT-5. THIS MAY SUGGEST THAT ZONE 2 IS DISCONTINUOUS TO THE SOUTHEAST OR IS CONFINED TO CHANNELS WHICH WERE NOT INTERCEPTED BY BORING AT-5.

4.1.2.3 ZONE 3

ZONE 3 IS CONSIDERED TO BE THE STIFF, OLIVE-BROWN, CLAYEY SILT STRATUM THAT FORMS THE LOWER BOUNDARY OF ZONE 2. ZONE 3 HAS BEEN ENCOUNTERED IN SEVERAL BORINGS, AS SHOWN IN FIGURE 8, AND CAN BE CORRELATED FROM OFF-SITE AREAS AROUND WELL AT-4 TO WELL CWP-13 AT THE SITE. THE THICKNESS OF ZONE 3 APPEARS TO VARY FROM 4 TO 6 FEET. THE LOW PERMEABILITY OF THE SOILS IN ZONE 3 ARE EXPECTED TO SIGNIFICANTLY RESTRICT THE VERTICAL MOVEMENT OF GROUND WATER.

4.1.2.4 ZONE 4

ZONE 4 IS CONSIDERED TO BE THE CLAYEY SAND AND GRAVEL STRATUM WHICH UNDERLIES ZONE 3. AS SHOWN IN FIGURE 8, THIS STRATUM APPEARS TO BE CONTINUOUS FROM THE PEAR ORCHARD TO AT LEAST THE EASTERN BOUNDARY OF THE SITE. THE SPARSITY OF DEEP BORINGS IN THE NORTHERN AND WESTERN PORTIONS OF THE SITE DOES NOT PERMIT FURTHER CORRELATION. IT IS NOTED, HOWEVER, THAT THE PERMEABILITY OF ZONE 4 APPEARS TO INCREASE TO THE SOUTHEAST. IN BORING CWP-13, ZONE 4 IS CHARACTERIZED AS A MEDIUM TO COARSE SAND WITH SOME SILT AND GRAVEL; AND IN BORING AA-5 AS A CLEAN SAND AND SANDY GRAVEL. THE WATER-PRODUCING CHARACTERISTICS OF ZONE 4 VARY ACCORDINGLY.

AN ALTERNATIVE SCENARIO FOR THE VARYING PERMEABILITY IS THAT TO THE NORTHWEST, ZONE 4 REPRESENTS THE TERRACE DEPOSITS DESCRIBED IN SECTION 4.1.1.2. TO THE SOUTHEAST, ZONE 4 MAY REPRESENT THE HOLOCENE ALLUVIUM ASSOCIATED WITH THE RUSSIAN RIVER OR ROBINSON CREEK.

4.2 GROUND WATER HYDROLOGY

THE FOLLOWING SECTIONS PROVIDE A SUMMARY OF GENERAL GROUND WATER CONDITIONS IN THE VALLEY FILL DEPOSITS OF THE UKIAH VALLEY AND A DESCRIPTION OF GROUND WATER OCCURRENCE IN THE STRATA ENCOUNTERED BENEATH THE CWP SITE.

4.2.1 REGIONAL GROUND WATER CONDITIONS

GROUND WATER OCCURS PRIMARILY IN THE VALLEY FILL DEPOSITS IN THE UKIAH VALLEY. IN THE CONTINENTAL BASIN DEPOSITS, GROUND WATER OCCURS UNDER CONFINED CONDITIONS AND WELLS COMPLETED IN THIS UNIT GENERALLY PRODUCE WATER "SLOWLY" BECAUSE OF THE FINE-GRAINED NATURE OF SEDIMENTS. THE SPECIFIC CAPACITIES OF 30 WELLS COMPLETED IN THE CONTINENTAL BASIN DEPOSITS RANGE FROM 0.004 TO 1.33 GALLONS/MINUTE/ FOOT AND "DRY HOLES" ARE NOT UNCOMMON (FARRAR, JULY 1986).

BECAUSE THEY ARE RELATIVELY THIN AND IMPERMEABLE, THE YOUNGER TERRACE DEPOSITS ARE NOT CONSIDERED A MAJOR SOURCE OF GROUND WATER. WELLS COMPLETED IN THE TERRACE DEPOSITS MAY YIELD SUFFICIENT WATER FOR LOW-CAPACITY DOMESTIC OR STOCK-WATERING WELLS. SPECIFIC CAPACITIES OF WELLS COMPLETED IN THE TERRACE DEPOSITS RANGE FROM 0.02 TO 7.1 GALLONS/MINUTE/FOOT AND FLUCTUATIONS IN THE WATER TABLE CAN "DRASTICALLY" AFFECT WELL PERFORMANCE (FARRAR, JULY 1986).

THE HOLOCENE ALLUVIUM IS CONSIDERED THE MOST PRODUCTIVE WATERBEARING UNIT IN THE UKIAH VALLEY AND PROVIDES "SUFFICIENT WATER FOR SUSTAINED PUMPAGE FOR MUNICIPAL AND IRRIGATION WELLS." THE MORE PERMEABLE, COARSER-GRAINED SEDIMENTS APPEAR TO BE LOCATED ALONG THE PRESENT COURSE OF THE RUSSIAN RIVER, AS EVIDENCED BY SEVERAL HIGH-PRODUCTION WELLS. THESE INCLUDE COMMUNITY WATER SUPPLY WELLS OPERATED BY THE WILLOW COUNTY WATER DISTRICT (WCWD), INCLUDING WELLS 14N/L2W-9AL AND -9A2 AND WELLS 15N/12W-33E3, -33E4, -33E5, AND -33E6. THE LOCATIONS OF THESE WELLS ARE SHOWN IN FIGURE 4. ALSO, A SERIES OF WELLS HAS BEEN INSTALLED ALONG THE WESTERN BANK OF THE RUSSIAN RIVER FROM SOUTH OF THE UKIAH SEWAGE DISPOSAL FACILITY TO THE EL ROBLES RANCH. THIS SERIES OF WELLS, SHOWN IN FIGURE 4, INCLUDES WELLS 14N/12W-4B, -4G, -4J, -4R1, AND -4R2. THESE WELLS SUPPLY WATER FOR IRRIGATION AND ARE BELIEVED TO DERIVE A PORTION OF THEIR PRODUCTION FROM SURFACE WATER IN THE RUSSIAN RIVER, INDUCED TO FLOW THROUGH PERMEABLE ALLUVIAL DEPOSITS AS THE GROUND WATER LEVEL IS LOWERED BY PUMPING. IT HAS BEEN REPORTED (FARRAR, JULY 1986) THAT UNDER MOST FLOW CONDITIONS, GROUND WATER MOVES FROM THE ALLUVIUM INTO THE RUSSIAN RIVER. DURING PERIODS OF HIGH WATER LEVELS IN THE RUSSIAN RIVER, HOWEVER, THE REVERSE SITUATION OCCURS.

ON A REGIONAL BASIS, GROUND WATER IN THE VALLEY FILL DEPOSITS FLOWS APPROXIMATELY NORTH TO SOUTH ALONG THE AXIS OF THE UKIAH VALLEY. NEAR THE WEST MARGIN OF THE VALLEY, HOWEVER, GROUND WATER GENERALLY FLOWS TO THE EAST, FOLLOWING THE TOPOGRAPHY. REGIONAL GROUND WATER CONTOURS ARE SHOWN IN FIGURE 4.

4.2.2 STUDY AREA GROUND WATER

IN THE STUDY AREA, GROUND WATER OCCURS PRIMARILY IN STRATIGRAPHIC ZONES 1 AND 2. THE FOLLOWING DISCUSSION FOCUSES ON THESE STRATA, AS THEY ARE OF PRIMARY CONCERN REGARDING THE MIGRATION OF CHROMIUM.

THE GROUND WATER FLOW" DIRECTION AND HYDRAULIC GRADIENT HAVE BEEN ESTABLISHED FROM WATER LEVEL DATA ACCUMULATED THROUGHOUT THE INVESTIGATIONS PERFORMED AT THE SITE. THESE DATA ARE SUMMARIZED IN TABLE B.L OF APPENDIX B. BASED ON WATER LEVEL MEASUREMENTS IN MONITORING WELLS COMPLETED IN ZONE 1, MADE BY CWP PERSONNEL IN JANUARY 1987, ZONE 1 GROUND WATER CONTOURS HAVE BEEN GENERATED. THESE ZONE 1 CONTOURS ARE SHOWN IN FIGURE 10. THE ZONE 1 GROUND WATER CONTOURS INDICATE AN OVERALL SOUTHEASTERLY DIRECTION OF FLOW WITH A HYDRAULIC GRADIENT OF ABOUT 0.005. THIS IS CONSISTENT WITH THE DIRECTION OF REGIONAL GROUND WATER FLOW SHOWN IN FIGURE 4. IN OFF-SITE AREAS TO THE SOUTHEAST OF THE SITE, THE CONTOURS INDICATE A FLOW DIRECTION TO THE SOUTH WITH APPROXIMATELY THE SAME HYDRAULIC GRADIENT.

AS SHOWN IN TABLE 1, THERE ARE ONLY THREE GROUND WATER MONITORING WELLS, WELLS CWP-15, CWP-22, AND AT-4, COMPLETED EXCLUSIVELY IN ZONE 2. THESE THREE DATA POINTS ARE NOT SUFFICIENT TO GENERATE GROUND WATER CONTOURS IN ZONE 2. COMPARISON OF THE GROUND WATER LEVELS IN WELLS CWP-18, CWP-22, AND AT-4 WITH THOSE IN ADJACENT ZONE 1 MONITORING WELLS, HOWEVER, INDICATES THAT THE ZONE 2 WATER LEVELS ARE APPROXIMATELY 1 FOOT BELOW THOSE IN ZONE 1. SEVERAL OTHER WELLS (WELLS CWP-7, CWP-8, CWP-9, CWP-14, AND CWP-19) ARE COMPLETED IN ZONES 1 AND 2. THE WATER LEVELS IN THESE WELLS GENERALLY APPEAR TO REFLECT ZONE 1 GROUND WATER LEVELS.

THE HYDRAULIC PROPERTIES OF THE WATER-BEARING ZONES HAVE BEEN INVESTIGATED BY PREVIOUS CONSULTANTS AND GEOSYSTEM BY MEANS OF SEVERAL PUMPING AND SLUG TESTS (GEOSYSTEM, MARCH 1986). THE DATA COLLECTED THROUGHOUT THESE INVESTIGATIONS HAVE BEEN SUMMARIZED BY GEOSYSTEM (SEPTEMBER 19, 1986). THESE DATA SUGGEST THAT HYDRAULIC CONDUCTIVITIES OF ZONES I AND 2 ARE GENERALLY ON THE ORDER OF (10-3) TO (10-2) CM/SEC. ZONES 3 AND 4 WERE CONSIDERED TO HAVE LOWER PERMEABILITY; HOWEVER, MORE RECENT STRATIGRAPHIC DATA (GEOSYSTEM, JANUARY 1987) SUGGEST THAT ZONE MAY BE HIGHLY PERMEABLE TO THE SOUTHEAST OF THE SITE. ZONES 3 AND 4 ARE OF LESS IMPORTANCE TO THE REMEDIATION OF CHROMIUM IN OFF-SITE AREAS. A SUMMARY OF THE HYDRAULIC PROPERTIES OF ZONE 1 IS PRESENTED IN TABLE 5 AND A SUMMARY OF THE HYDRAULIC CONDUCTIVITY DATA OBTAINED BY FIELD TESTS THROUGHOUT THE COURSE OF THE SITE CHARACTERIZATION STUDIES IS PRESENTED IN TABLE 6.

4.3 SURFACE WATER HYDROLOGY

THE RUSSIAN RIVER, WHICH ORIGINATES IN CENTRAL MENDOCINO COUNTY AND FLOWS SOUTH TO SONOMA COAST STATE BEACH, IS THE MOST IMPORTANT SURFACE DRAINAGE SYSTEM IN THE UKIAH VALLEY. AT ITS CLOSEST POINT, THE RUSSIAN RIVER FLOWS APPROXIMATELY 2,000 FEET TO THE EAST OF THE CWP SITE. FLOW IN THE RUSSIAN RIVER IS REGULATED BY CONTROLLING THE CONTRIBUTIONS FROM SEVERAL OF ITS MAJOR TRIBUTARIES. MINIMUM FLOWS ARE REQUIRED TO BE MAINTAINED, HOWEVER, AT VARIOUS LOCATIONS ON THE RUSSIAN RIVER. ONE OF THESE LOCATIONS IS AT THE JUNCTION OF THE EAST AND WEST FORKS OF THE RUSSIAN RIVER JUST NORTH OF UKIAH. AT THIS POINT, A MINIMUM FLOW OF APPROXIMATELY 150 CFS IS REQUIRED (DWR, MAY 1980). THE RUSSIAN RIVER HAS NUMEROUS BENEFICIAL USES, AS DESCRIBED IN SECTION 4.4.1.

TRIBUTARIES TO THE RUSSIAN RIVER INCLUDE NUMEROUS SMALL STREAMS ISSUING FROM THE MOUNTAINS THAT BORDER THE UKIAH VALLEY TO THE EAST AND WEST. THE MOST SIGNIFICANT OF THESE TRIBUTARIES IN THE VICINITY OF THE CWP SITE IS ROBINSON CREEK, WHICH MERGES WITH THE RUSSIAN RIVER AT A POINT ABOUT 4,500 FEET TO THE SOUTHEAST. THE LOCATIONS OF THE RUSSIAN RIVER AND ROBINSON CREEK, RELATIVE TO THE CWP SITE, ARE SHOWN IN FIGURE 1.

FLOW IN ROBINSON CREEK OCCURS ESSENTIALLY YEAR ROUND AND FOLLOWS THE NATURAL DRAINAGE COURSE. OTHER, SMALLER SURFACE DRAINAGE FEATURES FLOW ONLY WHEN PRECIPITATION OCCURS IN THE UKIAH VALLEY OR THE ADJACENT HIGHLANDS RESERVATIONS BY CWP PERSONNEL INDICATE THAT, DEPENDING ON THE INTENSITY AND DURATION OF THE RAINFALL, FLOW IN THESE SMALLER SURFACE DRAINAGE FEATURES MAY REACH THE RUSSIAN RIVER OR PERCOLATE INTO THE VALLEY FILL PRIOR TO REACHING THE RIVER. DURING THE WINTER MONTHS, WHEN THE WATER TABLE RISES TO WITHIN 2 OR 3 FEET OF THE LAND SURFACE, GROUND WATER MAY FLOW INTO THE LOW-LYING SURFACE DRAINAGE DITCHES. UNDER THESE CIRCUMSTANCES, WATER WOULD BE PRESENT IN THE DITCHES EVEN WHEN NO PRECIPITATION IS OCCURRING. SUCH WATER WOULD NOT, HOWEVER, BE REPRESENTATIVE OF STORM WATER RUNOFF ORIGINATING FROM THE CWP SITE.

FLOW IN THE MAJORITY OF THESE SMALLER SURFACE DRAINAGE FEATURES IS INTERMITTENT AND IS CONTROLLED AND DIVERTED BY CULVERTS AND DITCHES. SEVERAL SMALL DITCHES AND CULVERTS DIVERT

SURFACE WATER RUNOFF AROUND AND BENEATH THE CWP SITE. THE LOCATIONS OF THE DITCHES AND CULVERTS IN THE IMMEDIATE VICINITY OF THE SITE ARE SHOWN IN FIGURE 2. THE DITCHES THAT FLOW BENEATH AND AROUND THE CWP SITE REPORT TO A COMMON DITCH THAT FLOWS SOUTH, PARALLEL TO AND EAST OF TAYLOR DRIVE. THIS COMMON DITCH FLOWS EAST ALONG THE NORTHERN BOUNDARY OF THE ALEX THOMAS PEAR ORCHARD AND BENDS SOUTH ALONG THE RAILROAD TRACKS. FLOW IN THE DITCH, BY NOW AUGMENTED BY RUNOFF FROM THE PEAR ORCHARD AND THE RAILROAD CORRIDOR, ENTERS AN EAST-WEST LATERAL DRAIN WHICH DISCHARGES TO THE RUSSIAN RIVER. IT WAS OBSERVED IN OCTOBER 1987, THAT THE LATERAL DITCH CONTAINED SMALL AMOUNTS OF WATER; HOWEVER, THE OTHER TRIBUTARY DITCHES WERE DRY.

SURFACE WATER QUALITY IN THE RUSSIAN RIVER IS CONSIDERED TO BE OF "EXCELLENT TO GOOD QUALITY" IN TERMS OF MINERAL CONTENT (DWR, MAY 1980). USING ELECTRICAL CONDUCTIVITY (EC) AS AN INDICATOR OF MINERAL CONTENT, WATER QUALITY STANDARDS RECOMMEND AN EC OF LESS THAN 450 MICROMHOS. THE AVERAGE EC OF RUSSIAN RIVER WATER, BETWEEN POTTER VALLEY TO THE NORTH OF UKIAH AND HOPLAND TO THE SOUTH, RANGES FROM 140 TO 190 MICROMHOS. THE AVERAGE HARDNESS IS 115 MG/L (AS CACO3), WHICH IS CONSIDERED TO BE MODERATELY HARD AND NOT LIKELY TO ADVERSELY AFFECT MOST BENEFICIAL USES (DWR, MAY 1980). HIGH, NON-ORGANIC TURBIDITY IS AN OCCASIONAL PROBLEM IN THE RUSSIAN RIVER AND ITS TRIBUTARIES DURING PERIODS OF PROLONGED RAINFALL AND RELEASE OF WATER FROM LAKE MENDOCINO. THIS TURBIDITY MAY ALSO BE AGGRAVATED BY THE REMOVAL OF GRAVEL FOR USE IN CONSTRUCTION, AS THE DISTURBED RIVER CHANNEL CAN CONTRIBUTE SIGNIFICANT TURBIDITY TO WATER IN THE RUSSIAN RIVER.

4.4 BENEFICIAL USES OF WATER

THIS SECTION SUMMARIZES THE KNOWN BENEFICIAL USES OF SURFACE AND GROUND WATER IN THE UKIAH VALLEY IN THE VICINITY OF THE CWP SITE. THE BENEFICIAL USES OF SURFACE AND GROUND WATER HAVE BEEN SUMMARIZED PRIMARILY FROM AVAILABLE REPORTS PUBLISHED BY VARIOUS STATE GOVERNMENT AGENCIES. THE SOURCES OF INFORMATION ARE REFERENCED AS APPROPRIATE. AN INVENTORY OF WATER-PRODUCING WELLS IN THE VICINITY OF THE SITE HAS ALSO BEEN PERFORMED. IN ADDITION TO AIDING ASSESSMENT OF THE BENEFICIAL USES OF GROUND WATER, THE PURPOSE OF THE WELL INVENTORY WAS TO IDENTIFY AND LOCATE WELLS IN THE VICINITY OF THE SITE AND DOCUMENT WELL CONSTRUCTION DETAILS.

FOR THE PURPOSE OF THIS DISCUSSION, AND TO MAINTAIN CONSISTENCY WITH DWR WATER SUPPLY ASSESSMENT PROCEDURES, SURFACE WATER IS CONSIDERED TO BE "WATER FLOWING IN THE VARIOUS STREAM COURSES PLUS UNDERFLOW. UNDERFLOW MAY BE DEFINED AS SUBSURFACE WATER CONTAINED IN THE CHANNEL DEPOSITS, WHICH IF EXTRACTED, WOULD AFFECT STREAM FLOW WITHIN A SHORT PERIOD OF TIME" (DWR, MAY 1980). IT IS NOT UNCOMMON TO INSTALL WELLS IN THE COARSE, STREAM CHANNEL DEPOSITS IMMEDIATELY ADJACENT TO THE RUSSIAN RIVER AND EXTRACT UNDERFLOW. AS THE UNDERFLOW AND SURFACE WATERS ARE IN DIRECT HYDRAULIC COMMUNICATION, EXTRACTED UNDERFLOW IS CONSIDERED TO BE SURFACE WATER.

4.4.1 SURFACE WATER

THE RUSSIAN RIVER IS A MAJOR MUNICIPAL WATER SUPPLY FOR MENDOCINO, SONOMA, AND MARIN COUNTIES. IN ADDITION TO MUNICIPAL SUPPLY, WATER FROM THE RUSSIAN RIVER IS USED FOR AGRICULTURAL, INDUSTRIAL, AND RECREATIONAL PURPOSES.

ACCORDING TO THE WATER QUALITY CONTROL PLAN FOR THE NORTH COASTAL BASIN, THE SPECIFIC BENEFICIAL USES OF THE RUSSIAN RIVER INCLUDE:

- MUNICIPAL AND DOMESTIC SUPPLY
- AGRICULTURAL SUPPLY
- INDUSTRIAL SERVICE SUPPLY
- INDUSTRIAL PROCESS SUPPLY
- GROUND WATER RECHARGE
- NAVIGATION
- POTENTIAL HYDROPOWER GENERATION
- CONTACT WATER RECREATION
- NON-CONTACT WATER RECREATION
- WARM FRESHWATER HABITAT
- WILDLIFE HABITAT
- FISH MIGRATION
- FISH SPAWNING.

OTHER THAN CONTRIBUTING TO THE RUSSIAN RIVER, LITTLE INFORMATION IS AVAILABLE REGARDING DIRECT BENEFICIAL USES OF THE NUMEROUS SMALL TRIBUTARY STREAMS. THE BENEFICIAL USES OF WATER IN THE

TRIBUTARY DITCHES FLOWING AROUND THE CWP SITE, HOWEVER, INCLUDE WILDLIFE HABITAT AND, DURING PORTIONS OF THE YEAR, FRESHWATER HABITAT. IN ADDITION, GROUND WATER RECHARGE IS A BENEFICIAL USE OF THE WATER IN THESE TRIBUTARIES.

THE APPROXIMATE VOLUME OF SURFACE WATER FOR AGRICULTURAL AND URBAN USE IN 1975 WAS ESTIMATED TO BE 10,600 AND 6,000 ACRE-FEET, RESPECTIVELY. THE DEMAND ON SURFACE WATER RESOURCES IS PROJECTED TO INCREASE TO ABOUT 14,200 AND 6,800 ACRE-FEET FOR AGRICULTURAL AND URBAN USE, RESPECTIVELY, BY THE YEAR 2000 (DWR, MAY 1980).

4.4.2 GROUND WATER

BENEFICIAL USE OF THE GROUND WATER RESOURCES IN THE VICINITY OF THE CWP SITE INCLUDE PRIMARILY COMMUNITY WATER SUPPLY, DOMESTIC WATER SUPPLY, AND IRRIGATED AGRICULTURE.

IN GENERAL, WELL LOCATION AND THE PARTICULAR UNIT OF THE VALLEY FILL IN WHICH A WELL IS COMPLETED INFLUENCE YIELD AND THE BENEFICIAL USE OF THE EXTRACTED WATER. WELLS COMPLETED IN THE CONTINENTAL BASIN AND TERRACE DEPOSITS GENERALLY YIELD GROUND WATER IN AMOUNTS SUITABLE ONLY FOR LOW-CAPACITY DOMESTIC WELLS, STOCK-WATERING WELLS, OR LIMITED IRRIGATION WELLS (FARRAR, JULY 1986). WELLS COMPLETED IN THE HOLOCENE ALLUVIUM CAN YIELD SUFFICIENT WATER UNDER SUSTAINED PUMPING FOR MUNICIPAL AND IRRIGATION SUPPLY. WCWD EXTRACTS GROUND WATER FROM WELLS LOCATED IN THE NORGARD LANE WELL FIELD, APPROXIMATELY 2,200 FEET NORTH OF THE CWP SITE, AND FROM TWO WELLS NEAR THE RUSSIAN RIVER, APPROXIMATELY 8,000 FEET SOUTH OF THE CWP SITE.

4.5 SOIL, STORM WATER, AND GROUND WATER QUALITY

THIS SECTION PRESENTS THE DISTRIBUTION AND OCCURRENCE OF CHROMIUM AND OTHER INDICATOR PARAMETERS IN SOIL, STORM WATER, AND GROUND WATER IN THE STUDY AREA. THROUGHOUT THE REMAINDER OF THIS REPORT, HEXAVALENT CHROMIUM IS REFERRED TO AS CR(VI) AND TRIVALENT CHROMIUM IS REFERRED TO AS CR (III). UNLESS SPECIFIED OTHERWISE, CHROMIUM REFERS TO TOTAL CHROMIUM. WATER AND SOIL QUALITY DATA HAVE BEEN GENERATED OVER SEVERAL YEARS OF SITE CHARACTERIZATION STUDIES AND MONITORING. GROUND WATER, STORM WATER, AND SOIL QUALITY DATA ARE CONTAINED IN APPENDICES B, C, AND D, RESPECTIVELY, AND ARE SUMMARIZED IN THE FOLLOWING SECTIONS.

4.5.1 DISTRIBUTION OF CHROMIUM, ARSENIC, AND COPPER IN SOIL

A TOTAL OF 26 SOIL BORINGS (BORINGS S-1 THROUGH S-26) WERE DRILLED (D'APPOLONIA/IT CORPORATION, MAY 1984) IN THE STUDY AREA TO ASSESS THE AREAL EXTENT OF CHROMIUM, ARSENIC, AND COPPER IN SOIL GO A DEPTH OF ABOUT 20 FEET. SOIL SAMPLES WERE COLLECTED AT DEPTHS OF 1, 3, 6, 10, IS, AND 20 FEET. NEAR-SURFACE SOIL SAMPLES FROM DEPTHS OF 1 AND 2 FEET WERE ALSO COLLECTED FROM 17 OTHER LOCATIONS (G-1 THROUGH G-17) TO FURTHER DELINEATE THE AREAL DISTRIBUTION OF CHEMICALS IN NEAR-SURFACE SOILS. THE LOCATIONS OF THE SOIL SAMPLING STATIONS ARE SHOWN IN FIGURE 11. ALL SOIL SAMPLES WERE ANALYZED FOR TOTAL OR HEXAVALENT CHROMIUM, ARSENIC, AND COPPER. A SUMMARY OF THE DATA IS PRESENTED IN TABLES D.1 THROUGH D.4 OF APPENDIX D. PLOTS OF CHROMIUM CONCENTRATIONS WITH DEPTH FOR SELECTED BORINGS ARE ALSO INCLUDED IN APPENDIX D. ALL CONCENTRATIONS REFLECT THE TOTAL QUANTITY OF THE METALS PRESENT IN THE SAMPLES. THE SAMPLE ID PROVIDES A DESIGNATION FOR EITHER A BORING (5) OR A SURFACE SAMPLE (G), FOLLOWED BY A NUMBER IDENTIFYING THE LOCATION. THE LAST NUMBER IN THE DESIGNATION IDENTIFIES THE DEPTH AT WHICH THE SAMPLE WAS COLLECTED. FROM A GENERAL REVIEW OF THE DATA, THE FOLLOWING OBSERVATIONS CAN BE MADE:

- ELEVATED CHROMIUM CONCENTRATIONS EXIST IN THE UPPER 3 FEET OF SOIL AND ESPECIALLY IN THE TOP 1 FOOT (G10, 1'; S-4, 1'; S-8, 0'; S-5, 0")

- CHROMIUM CONCENTRATIONS IN SAMPLES COLLECTED FROM MORE THAN 3 FEET BELOW THE SURFACE ARE GENERALLY LOWER THAN 50 MG/KG IN ALL BORINGS, EXCEPT IN 5-8 AT THE 10-FOOT DEPTH AND 5-10 AT THE 15-FOOT DEPTH.

- CHROMIUM CONCENTRATIONS ARE HIGHER IN BORINGS NEAR THE RETORT AND SUMP AREAS.

- THE MAXIMUM DETECTED CONCENTRATIONS OF CHROMIUM, COPPER, AND ARSENIC IN SURFICIAL SOILS ARE 540, 230 AND 220 MG/KG, RESPECTIVELY (APPENDIX D).

- GENERALLY, THERE APPEARS TO BE GOOD CORRELATION BETWEEN CHROMIUM, ARSENIC, AND COPPER CONCENTRATIONS.

IN ORDER TO COMPARE BACKGROUND CHROMIUM CONCENTRATIONS IN AREAS NOT AFFECTED BY CWP OPERATIONS, WITH AREAS THAT ARE POSSIBLY IMPACTED BY WOOD PRESERVING OPERATIONS, THE DATA FOR BORINGS S-1 (UPGRADIENT), 6 (BACKGROUND), S-5, S-8, S-10 (RETORT AND SUMP AREA), S-15, S-22, AND S-25 (DOWNGRADIENT) HAVE BEEN SUMMARIZED IN TABLE D-4 (APPENDIX D). BORING S-8 IS LOCATED AT THE EASTERN END OF THE RAIL LINES AND BORING S-10 IS THE CLOSEST BORING TOPOGRAPHICALLY DOWNGRADIENT OF THE RETORTS. IT SHOULD BE NOTED THAT NO SAMPLES HAVE BEEN COLLECTED FROM UNDER THE RETORT/PROCESS AREA. SAMPLING IN THESE AREAS IS NOT POSSIBLE DURING NORMAL FACILITY OPERATION. THE SALIENT FEATURES OF THE DATA INCLUDE THE FOLLOWING:

- HIGHER CHROMIUM CONCENTRATIONS ARE OBSERVED IN THE SURFACE SAMPLES NEAR THE RETORT AND SUMP AREAS.

- CHROMIUM CONCENTRATIONS IN BORING S-1 (UPGRADIENT) SAMPLES COLLECTED BELOW THE 3-FOOT DEPTH ARE GENERALLY IN THE SAME RANGE AS THOSE OBSERVED IN OTHER BORINGS.

- THE BACKGROUND AND UPGRADIENT CONCENTRATIONS OF CHROMIUM, ARSENIC, AND COPPER IN BORINGS S-26 AND S-1 SAMPLES ARE GENERALLY LESS THAN 50 /KG, LESS THAT 14 MG/KG, AND LESS THAN 20 MG/KG, RESPECTIVELY.

SOIL SAMPLES CONTAINING CHROMIUM CONCENTRATIONS GREATER THAN 100 MG/KG WERE SELECTED TO REPRESENT SURFACE SOILS WITH DEFINITE CHROMIUM CONTAMINATION. THE APPROXIMATE AREA OF SUCH CONTAMINATION IS SHOWN IN FIGURE 11. THE MAJORITY OF THE SURFACE SOILS CONTAINING ELEVATED CHROMIUM CONCENTRATIONS ARE IN THE AREA AROUND THE RETORT AND SUMP UNITS WHERE FRESHLY TREATED WOOD HAS BEEN STORED. A NARROW BAND OF SURFACE SOILS WITH APPROXIMATELY 100 MG/KG OR CHROMIUM IS PRESENT TO THE SOUTH OF THE RETORT CHAMBERS. THE AREAL EXTENT OF ELEVATED ARSENIC CONCENTRATIONS IN THE NEAR-SURFACE SOILS IS SIMILAR TO CHROMIUM DISTRIBUTION EXCEPT IN ISOLATED AREAS WITH NEAR BACKGROUND CONCENTRATIONS (C-3, C-7, C-8). THE APPROXIMATE AREAS ENCOMPASSING GREATER THAN 14 MG/KG ARSENIC CONCENTRATION ARE SHOWN IN FIGURE 11.

4.5.2 STORM WATER QUALITY

THIS SECTION SUMMARIZES THE AVAILABLE WATER QUALITY DATA OBTAINED FROM STORM WATER SAMPLES COLLECTED AT THE CWP SITE. FLOW IN THE DITCHES AND CULVERTS AROUND AND BENEATH THE CWP SITE OCCURS AS A RESULT OF PRECIPITATION IN THE UKIAH VALLEY OR THE ADJACENT HIGHLANDS. AS NOTED IN SECTION 4.3, GROUND WATER MAY BE PRESENT IN LOW-LYING DRAINAGE DITCHES ON A CONTINUOUS BASIS DURING THE WINTER MONTHS. A DIFFERENTIATION IS MADE, HOWEVER, BETWEEN THIS WATER AND STORM WATER RUNOFF.

A SURFACE OR STORM WATER MONITORING PROGRAM IS IN EFFECT AT THE SITE AND SEVERAL STORM WATER MONITORING LOCATIONS HAVE BEEN ESTABLISHED. CURRENTLY, THE STORM WATER MONITORING PROGRAM INCLUDES COLLECTION OF SAMPLES FROM STATIONS NE, NW, AND C-100. UP UNTIL DECEMBER 1984, STATIONS SE AND SW WERE ALSO MONITORED. THE LOCATIONS OF THESE STATIONS ARE SHOWN IN FIGURE 2. PRIOR TO INSTITUTING SURFACE WATER FLOW CONTROL AT THE CWP SITE, STORM WATER SAMPLES WERE PERIODICALLY COLLECTED AND ANALYZED. RWQCB STAFF HAVE INDICATED THAT THE MEASURED CONCENTRATIONS OF METALS IN 1980 AND 1981 WERE MUCH HIGHER THAN IN SUBSEQUENT YEARS.

MONITORING STATION NW IS LOCATED AT THE ENTRANCE TO THE CULVERT THAT CONDUCTS STORM WATER UNDER THE CWP SITE FROM THE WEST SIDE OF US HIGHWAY 101. THE WATER QUALITY DATA COLLECTED AT THIS LOCATION IS CONSIDERED TO REPRESENT UPGRADIENT OR BACKGROUND CONDITIONS.

MONITORING STATION NE IS LOCATED ON TAYLOR DRIVE AT THE CONFLUENCE OF THE ABOVE-MENTIONED CULVERT AND THE DITCH AROUND THE NORTHEASTERN PORTION OF THE PERIMETER OF THE CWP SITE. DATA COLLECTED AT THIS LOCATION PROVIDE AN INDICATION OF THE QUALITY OF SURFACE RUNOFF FROM THE NORTHERN PORTION OF THE CWP SITE. IT IS NOTED, HOWEVER, THAT ASPHALT BERMS HAVE BEEN CONSTRUCTED TO DIVERT SURFACE RUNOFF FROM TREATED WOOD STORAGE AREAS TO A COLLECTION SUMP. FROM THIS SUMP, THE WATER IS RECYCLED INTO CWP'S WOOD PRESERVING OPERATIONS.

MONITORING STATION C-100 IS LOCATED APPROXIMATELY 100 FEET DOWNSTREAM OF THE CONFLUENCE OF FLOW PASSING FROM STATION NE AND THAT FLOWING BENEATH THE CWP SITE THROUGH A SECOND CULVERT NEAR THE SOUTHERN SITE BOUNDARY. COMPARISON OF DATA COLLECTED FROM THIS LOCATION WITH THAT FROM MONITORING STATION PROVIDES AN INDICATION OF THE OVERALL IMPACT OF SURFACE RUNOFF FROM THE CWP SITE ON STORM WATER QUALITY.

IT IS NOTED THAT AREAS OTHER THAN THE CWP SITE ALSO CONTRIBUTE TO FLOW AT ALL THREE STORM WATER MONITORING STATIONS. THE POSSIBLE IMPACT OF THESE CONTRIBUTIONS MUST BE CONSIDERED WHEN EVALUATING STORM WATER QUALITY.

STORM WATER SAMPLES ARE CURRENTLY ANALYZED FOR DISSOLVED TOTAL CHROMIUM AND ARSENIC; HOWEVER, IN THE PAST, ANALYSES FOR DISSOLVED CR(VI) AND COPPER HAVE ALSO BEEN PERFORMED. THE MOST RECENT AND COMPREHENSIVE DATA, REPRESENTING JANUARY 1988, ARE PRESENTED IN TABLE 7. THE HISTORICAL STORM WATER QUALITY DATA ARE SUMMARIZED IN APPENDIX C. THE DATA INDICATE THAT CHROMIUM, ARSENIC, AND COPPER ARE OCCASIONALLY PRESENT AT DETECTABLE CONCENTRATIONS IN STORM WATER FLOW SAMPLED AT STATIONS NE AND C-100. IT IS NOTED, HOWEVER, THAT THE MEASURED CONCENTRATIONS ARE TYPICALLY CLOSE TO THE DETECTION LIMITS AND THE CONCENTRATION OF CR(VI) HAS OCCASIONALLY EXCEEDED THE DRINKING WATER STANDARD OF 0.05 MG/1 WITHIN THE LAST FIVE YEARS. CHROMIUM, ARSENIC, AND COPPER CONCENTRATIONS IN SAMPLES COLLECTED FROM MONITORING STATION HAVE BEEN AT OR BELOW DETECTION LIMITS SINCE 1983, WITH THE EXCEPTION OF ARSENIC WHICH WAS MEASURED AT 0.006 MG/L IN JANUARY 1986 AT STATION NW. THE MOST RECENT DATA, REPRESENTING APRIL 1988, SHOW NON-DETECTABLE CONCENTRATIONS OF CHROMIUM AND ARSENIC IN MONITORING STATIONS C-100,NE, AND NW.

IN ADDITION TO CWP'S MONITORING, THE RWQCB STAFF HAVE OBTAINED STORM WATER SAMPLES SINCE 1984 WHICH HAVE BEEN ANALYZED FOR CR(III), CR(VI), ARSENIC, AND COPPER. THE POTENTIAL IMPACT FROM PAST AND CURRENT DISCHARGES ARE DISCUSSED IN SECTION 6.0.

4.5.3 GROUND WATER QUALITY

GROUND WATER QUALITY MONITORING HAS BEEN PERFORMED AT THE CWP SITE SINCE 1981. THE CHEMICAL ANALYSES HAVE GENERALLY INCLUDED TOTAL DISSOLVED CHROMIUM, ARSENIC, AND COPPER WITH OCCASIONAL MEASUREMENTS OF DISSOLVED CR (VI). THE COMPREHENSIVE GROUND WATER QUALITY DATA, REPRESENTING JANUARY 1988 CONDITIONS, ARE PRESENTED IN TABLE 7. ALL HISTORICAL GROUND WATER QUALITY DATA HAVE BEEN SUMMARIZED IN TABLE B.2 OF APPENDIX B. THE WATER QUALITY DATA INDICATE THAT:

- THE WELLS COMPLETED IN ZONE 1 NEAR THE RETORT AREA GENERALLY EXHIBIT HIGHER CHROMIUM CONCENTRATIONS AND THE CONCENTRATIONS DECREASE HYDRAULICALLY DOWNGRADIENT.

- THE MAXIMUM DETECTED CONCENTRATIONS OF TOTAL CHROMIUM AND HEXAVALENT CHROMIUM IN GROUND WATER OCCURRED IN WELL CWP-6 AT 125 AND 78 MG/L, RESPECTIVELY.

- CHROMIUM CONCENTRATIONS HAVE GENERALLY DECREASED WITH TIME. WELLS CWP-2A, CWP-2B, CWP-6 (NEAR RETORT AREA), CWP-8, CWP-11 (NEAR SITE BOUNDARY), AND FPT-3, FPT-4, FPT-5, AT-1 (OFF SITE) SUPPORT THIS OBSERVATION.

- THE CONCENTRATIONS OF CHROMIUM IN ON-SITE WELLS COMPLETED IN ZONE 2 ARE NOT SIGNIFICANT AND MAY RESULT FROM LIMITED COMMUNICATION WITH ZONE 1.

- ZONE 2 DOES NOT CONTAIN ELEVATED CHROMIUM CONCENTRATIONS IN OFF-SITE AREAS.

- ZONE 2 AND 4 DO NOT APPEAR TO BE IMPACTED BY THE PRESENCE OF CHROMIUM.

SELECTED GROUND WATER QUALITY DATA HAVE BEEN USED TO GENERATE CHROMIUM ISOCONCENTRATIONS TO PROVIDE AN AREAL REPRESENTATION OF THE CHROMIUM PLUME IN GROUND WATER. DATA FROM JANUARY/FEBRUARY 1986, APRIL 1987, AND JANUARY 1988 ARE USED TO PLOT ISOCONCENTRATIONS, AS SHOWN IN FIGURES 12, 13, AND 14, RESPECTIVELY. THESE FIGURES INDICATE THAT ELEVATED CHROMIUM CONCENTRATIONS ARE PRESENT IN GROUND WATER PRIMARILY IN ON-SITE AREAS TO THE WEST OF THE SLURRY WALL. COMPARISON BETWEEN THE THREE SETS OF ISOCONCENTRATIONS INDICATES THE APPARENT TREND OF DECREASING CHROMIUM CONCENTRATIONS WITH TIME IN MONITORING WELLS LOCATED HYDRAULICALLY DOWNGRADIENT OF THE SLURRY CUTOFF WALL. IT SHOULD BE NOTED THAT THESE ISOCONCENTRATIONS HAVE BEEN DEVELOPED BASED ON DATA OBTAINED FROM ALL WELLS AND DO NOT DIFFERENTIATE BETWEEN THE VARIOUS STRATIGRAPHIC ZONES. HOWEVER, THE DATA REPRESENT PRIMARILY THE WATER QUALITY OF ZONE 1.

OF THE GROUND WATER MONITORING WELLS LOCATED HYDRAULICALLY DOWNGRADIENT OF THE SLURRY CUTOFF WALL, ONLY WELLS CWP-8 AND AT-2 HAVE OCCASIONALLY INDICATED THE PRESENCE OF CHROMIUM IN EXCESS OF THE DRINKING WATER STANDARD (0.05 MG/L). IN 1988, CHROMIUM CONCENTRATIONS IN WELL CWP-8 EXCEEDED THE DRINKING WATER STANDARD TWICE. OTHER OBSERVATIONS SHOWED CHROMIUM CONCENTRATIONS AT OR BELOW THE DETECTION LIMIT OF 0.01 MG/L. THE MOST RECENT DATA, FOR JUNE AND JULY 1989, SHOW LESS THAN 0.02 MG/L CHROMIUM CONCENTRATION IN WELL CWP-8. IN 1988, CHROMIUM CONCENTRATIONS IN

WELL CWP-8 RANGED FROM LESS THAN 0.02 TO 0.05 MG/L. EIGHT OBSERVATIONS SHOWED LESS THAN 0.02 MG/L CHROMIUM CONCENTRATIONS. EXCEPT IN JANUARY 1989, WHERE 0.04 MG/1 CHROMIUM WAS DETECTED, ALL OTHER DATA FOR 1989 SHOW LESS THAN 0.01 MG/1 CHROMIUM CONCENTRATION IN WELL AT-2. WELL AT-2 IS COMPLETED ENTIRELY WITHIN ZONE 1; HOWEVER, OTHER ZONE 1 MONITORING WELLS DOWNGRADIENT OF WELL AT-2 HAVE NOT SHOWN THE PRESENCE OF CHROMIUM. ALSO, ZONE 1 IN THE VICINITY OF WELL AT-2 DOES NOT CONTAIN DETECTABLE LEVELS OF CHROMIUM (GEOSYSTEM, JANUARY 1987).

TO DEMONSTRATE THE TREND OF DECREASING CHROMIUM CONCENTRATIONS WITH TIME, WATER QUALITY DATA OBTAINED FROM WELLS CWP-6, FPT-3, AND AT-I HAVE BEEN PLOTTED IN FIGURES 15, 16, AND 17, RESPECTIVELY. THE REDUCTION IN CONCENTRATION IS MORE EVIDENT IN OFF-SITE WELLS FPT-3 AND AT-I AS COMPARED WITH ON-SITE WELL CWP-6. THE DECLINE IN CHROMIUM CONCENTRATION WITH TIME IN WELL CWP-8, ON A SEMILOGARITHMIC BASIS, IS SHOWN IN FIGURE 18. THE AREA NEAR WELL CWP-8 IS ASSUMED TO BE THE POTENTIAL SOURCE OF CHROMIUM TO OFF-SITE AREAS, SINCE IT IS TO THE EAST OF THE SLURRY WALL AND NOT CONTAINED BY ON-SITE REMEDIATION EFFORTS. THE WATER QUALITY DATA FOR WELL CWP-6 (FIGURE 15) SHOW A CONSIDERABLE REDUCTION IN CHROMIUM CONCENTRATIONS FROM OVER 120 MG/L IN 1981 TO ABOUT 50 MG/L IN JUNE 1985. SINCE 1985, CHROMIUM CONCENTRATIONS HAVE VARIED SOMEWHAT; HOWEVER, THE OVERALL CONCENTRATIONS HAVE NOT CHANGED SIGNIFICANTLY. SIMILAR REDUCTIONS IN CHROMIUM CONCENTRATIONS CAN BE OBSERVED IN FIGURES 16 AND 17 FOR WELLS FPT-3 AND AT-2, RESPECTIVELY. THE CHROMIUM CONCENTRATIONS IN WELLS FPT-3 AND AT-I GENERALLY DEMONSTRATE A STEADY DECLINE IN CHROMIUM CONCENTRATIONS. THE CHROMIUM CONCENTRATION IN WELL FPT-3 HAS BEEN BELOW THE DRINKING WATER STANDARD OF 0.05 MG/L SINCE FEBRUARY 1986. ALSO, THE MOST RECENT WATER QUALITY DATA FOR WELL AT-2 (TABLE B-2 OF APPENDIX B) INDICATE THE CONCENTRATION OF CHROMIUM IS GENERALLY BELOW THE DETECTION LIMIT OF 0.02 MG/1. THE TRENDS IN CHROMIUM CONCENTRATIONS IN OFF-SITE AREAS ARE DISCUSSED FURTHER IN SECTION 6.0, WHICH ADDRESSES MIGRATION PATHWAYS AND RISK ASSESSMENT.

4.6 INDICATOR PARAMETERS

SITE CHARACTERIZATION STUDIES HAVE SHOWN THE PRESENCE OF CHROMIUM, COPPER, AND ARSENIC IN SOIL AND THE PRESENCE OF CHROMIUM IN GROUND WATER. THESE COMPOUNDS, THEREFORE, ARE CONSIDERED TO BE INDICATOR PARAMETERS FOR USE IN FURTHER SITE CHARACTERIZATION STUDIES AND POSSIBLE SOIL REMEDIATION ACTIVITIES. FOR MONITORING AND GROUND WATER REMEDIATION, HOWEVER, DISSOLVED TOTAL CHROMIUM AND CR(VI) ARE CONSIDERED TO BE THE MOST RELEVANT INDICATOR PARAMETERS. THE RATIONALE FOR THIS SELECTION IS THAT CHROMIUM COMPOUNDS, PARTICULARLY CR(VI), ARE MORE SOLUBLE AND MORE MOBILE IN THE SUBSURFACE ENVIRONMENT THAN ARSENIC AND COPPER COMPOUNDS. IN ADDITION, PREVIOUS MONITORING EFFORTS HAVE NOT DETECTED COPPER OR ARSENIC IN GROUND WATER.

4.7 GEOCHEMICAL PROPERTIES

TO EVALUATE THE MIGRATION RATE AND LEACHING CHARACTERISTICS OF CHROMIUM, A NUMBER OF GEOCHEMICAL TESTS WERE PERFORMED. THESE TESTS INCLUDED CHEMICAL ANALYSES FOR TOTAL CHROMIUM, CR (VI), ORGANIC MATTER, WASTE EXTRACTION TESTS (WET), BATCH SORPTION TESTS, AND COLUMN DESORPTION TESTS. DETAILED DESCRIPTIONS OF THESE TESTS AND TEST RESULTS HAVE BEEN SUBMITTED PREVIOUSLY (IT CORPORATION, JUNE 1985); HOWEVER, THE FINDINGS OF THESE STUDIES, PERTINENT TO THE RAP, ARE SUMMARIZED BELOW.

4.7.1 SOIL SAMPLE ANALYSES

NINE SOIL SAMPLES WERE SELECTED FOR ANALYSES TO DETERMINE THE RELATIVE CONCENTRATIONS OF TOTAL CHROMIUM AND CR(VI). THE RESULTS ARE PRESENTED IN TABLE D-5 OF APPENDIX D. THE DATA SHOW THAT THE CONCENTRATIONS OF CR(VI) IN THE SAMPLES ANALYZED ARE GENERALLY LESS THAN 10 PERCENT OF THE TOTAL CHROMIUM CONTENT. FROM THE DATA IT CAN BE CONCLUDED THAT MOST OF THE CHROMIUM PRESENT IN THE SOIL IS NOT IN HEXAVALENT FORM. PREVIOUS STUDIES HAVE SHOWN THAT THE TRIVALENT FORMS OF CHROMIUM UNDER NEUTRAL CONDITIONS ARE LESS SOLUBLE AND MORE SUBJECT TO ADSORPTION. CR(III) IS, THUS, LESS SUSCEPTIBLE TO DISSOLUTION AND IS LESS MOBILE.

THE ORGANIC CONTENT OF THE SOIL SAMPLES, REPORTED IN TABLE D-5 OF APPENDIX D, VARIED FROM LESS THAN 0.1 TO 0.86 PERCENT. ALTHOUGH THE ORGANIC CONTENT OF THE SOIL MAY NOT BE DIRECTLY RESPONSIBLE FOR ADSORPTION OF CR(VI), IT MAY REDUCE CR(VI) TO CR(III) (STOLLENWERK AND GROVE, 1985; JAMES AND BARTLETT, 1983). BECAUSE OF THE COMPLEXITY OF THE GEOCHEMICAL REACTIONS, THE OVERALL EFFECT OF ORGANIC MATTER ON THE REDUCTION OF CR(VI) TO CR(III) CANNOT BE ASSESSED.

4.7.2 WASTE EXTRACTION TESTS

TO EVALUATE THE LEACHING CHARACTERISTICS OF THE CONTAMINATED SOIL WITH RESPECT TO DISSOLVED TOTAL CHROMIUM, WASTE EXTRACTION TESTS (WETS) WERE PERFORMED ACCORDING TO THE GUIDELINES ISSUED BY THE DHS (JANUARY 1984). THE RATIONALE FOR PERFORMING THE TESTS FOR TOTAL CHROMIUM WAS THAT IT HAS BEEN SHOWN THAT A LARGE PERCENTAGE OF THE CHROMIUM IN THE SOIL IS IN TRIVALENT FORM. THE WET RESULTS ARE PRESENTED IN TABLE D.6 OF APPENDIX D. THE RESULTS SHOW THAT ACCORDING TO EXISTING CRITERIA THE SOIL IS NOT CONSIDERED A HAZARDOUS WASTE. ALTHOUGH THE WET RESULTS DO NOT PROVIDE ANY INFORMATION ON THE LONG-TERM LEACHABILITY OF CR (VI), THE TEST WAS DESIGNED TO EVALUATE THE LEACHING CHARACTERISTICS OF TOTAL CHROMIUM IN SOIL UNDER AGGRESSIVE ACIDIC CONDITIONS. THE LONG-TERM LEACHING BEHAVIOR OF CR(VI) COULD BE ASSESSED IF SUFFICIENT FIELD DATA WERE AVAILABLE. AT THIS TIME, HOWEVER, THE COLLECTION AND EVALUATION OF SUCH DATA, UNDER PARTIALLY SATURATED FLOW CONDITIONS AND IN HETEROGENEOUS SOILS, IS STILL IN THE RESEARCH STAGE.

4.7.3 SORPTION TESTS

TO EVALUATE THE MIGRATION CHARACTERISTICS OF CR(VI) IN GROUND WATER, BATCH SORPTION TESTS WERE PERFORMED ON UNCONTAMINATED SOIL SAMPLES. THE TESTS WERE PERFORMED ON TWO SAMPLES; ONE REPRESENTING THE SILTY CLAY MATERIAL OF ZONE 1 AND THE OTHER THE SAND AND GRAVEL OF ZONE 2. THE TESTS WERE PERFORMED FOR TWO INITIAL CONCENTRATIONS OF 1 AND 10 MG/L. THE RESULTS DEMONSTRATED THAT THE DISTRIBUTION COEFFICIENT (KD) VARIES FROM 0.65 TO 2.98 ML/G AND THE CORRESPONDING RETARDATION FACTORS (R) RANGE FROM 4.9 TO 12.4. THE RETARDATION FACTOR OF 4.9 REPRESENTS THE MINIMUM CALCULATED VALUE FOR THE SAND AND GRAVEL LAYER.

THE RESULTS OF BATCH SORPTION TESTS DEMONSTRATE THAT ADSORPTION ON THE SOIL MATRIX CAN OCCUR, RETARDING THE MIGRATION OF CR(VI). EVEN THOUGH ALL THE ADSORPTION MECHANISMS AND THEIR RELATIVE CONTRIBUTIONS ARE NOT KNOWN, THE RESULTS OF PREVIOUS STUDIES (STOLLENWERK AND GROVE, 1985) SUPPORT THE CONCLUSION THAT ADSORPTION OF CR(VI) ON ALLUVIAL MATERIALS IS LIKELY. THIS IS PARTICULARLY TRUE FOR SOILS CONTAINING HIGH CONCENTRATIONS OF IRON OXIDES. THE RESULTS OF THE SORPTION TESTS HAVE BEEN UTILIZED IN EVALUATING THE MIGRATION BEHAVIOR OF CHROMIUM (SECTION 6.0).

4.7.4 DESORPTION TESTS

DESORPTION TESTS HAVE BEEN PERFORMED TO EVALUATE THE BEHAVIOR OF CR(VI) IN THE PORE FLUID AS NONCONTAMINATED WATER FLOWS THROUGH CONTAMINATED SOIL. TWO SOIL SAMPLES, ONE CLASSIFIED AS SANDY GRAVEL AND THE OTHER AS CLAYEY SILT, WERE USED FOR THE DESORPTION STUDIES. SOLUTIONS OF SODIUM CHROMATE WERE FIRST USED TO CONTAMINATE THE SOIL SAMPLES. THE INITIAL CONCENTRATION OF THE INFLUENT TO THE SOIL COLUMNS WAS 10 MG/L. HOWEVER, SINCE ACHIEVING STEADY STATE CONDITIONS APPEARED TO BE VERY SLOW, THE INFLUENT CONCENTRATIONS WERE INCREASED TO 190 MG/L. THE RESULT OF THE CONTAMINATION PHASE OF THE DESORPTION TESTS SHOWED THAT MORE THAN 70 PORE VOLUMES WERE REQUIRED TO ACHIEVE STEADY STATE CONDITIONS. THIS MAY BE AN INDICATION THAT THE SOILS EXHIBIT A CONSIDERABLE ADSORPTIVE CAPACITY FOR CR(VI). LIMITED DATA ON THE IRON CONTENT OF THE SOILS UNDERLYING THE SITE INDICATED THE PRESENCE OF ABOUT 23,500 MG/KG OF IRON. OXIDES AND HYDROXIDES OF IRON MAY CONTRIBUTE TO THE ADSORPTION OF CR(VI) (STOLLENWERK AND GROVE, 1985; JAMES AND BARTLETT, 1983).

THE DESORPTION PHASE WAS CONDUCTED BY REPLACING THE INFLUENT SOLUTION WITH DISTILLED WATER. THE DATA SHOWED THAT ABOUT 10 PORE VOLUMES WERE REQUIRED TO REDUCE THE EFFLUENT CONCENTRATION OF CR(VI) FROM APPROXIMATELY 185 MG/L TO ABOUT 0.1 MG/L. THE RESULTS ALSO SHOWED THAT, IN THE LOW CONCENTRATION RANGE, THE RATE OF REDUCTION IN CONCENTRATION WAS VERY SLOW. HOWEVER, IT SHOULD BE NOTED THAT DESORPTION PER SE IS NOT A SLOW PROCESS.

IT SHOULD ALSO BE POINTED OUT THAT THE SORPTION AND DESORPTION STUDIES WERE CONDUCTED USING DISTILLED WATER AS A SOLVENT. THIS MAY AFFECT THE SORPTION/DESORPTION CHARACTERISTICS AS COMPARED TO THE ACTUAL FIELD CONDITIONS WHERE THE GROUND WATER CONTAINS A NUMBER OF OTHER CHEMICAL COMPOUNDS. FOR INSTANCE, THE ADSORPTION OF CR(VI) IN THE PRESENCE OF OTHER SALTS MAY BE REDUCED (STOLLENWERK AND GROVE, 1985) AND THE DESORPTION MAY BE ENHANCED. HOWEVER, THE LABORATORY DATA USING DISTILLED WATER ARE CONSIDERED TO HAVE GENERATED USEFUL INFORMATION UNDER HIGHLY CONTROLLED CONDITIONS. SINCE, THE GROUND WATER CHARACTERISTICS VARY WITH TIME UNDER ACTUAL FIELD CONDITIONS, IT APPEARS THAT THE LONG TERM GEOCHEMICAL BEHAVIOR CAN BEST BE EVALUATED BY STUDYING FIELD DATA. THE ADVANTAGE OF THIS APPROACH IS THAT ANY OBSERVATIONS REFLECT THE AGGREGATE EFFECT OF ALL HYDROGEOLOGIC AND GEOCHEMICAL PROCESSES OCCURRING IN THE FIELD.

THE GROUND WATER LEVEL FLUCTUATIONS AND WATER QUALITY DATA HAVE BEEN REVIEWED TO ASSESS POSSIBLE CORRELATION BETWEEN GROUND WATER LEVEL AND CHROMIUM CONCENTRATIONS. ALTHOUGH CERTAIN WELLS EXHIBITED A DISCERNABLE TREND OF INCREASING CHROMIUM CONCENTRATIONS WITH RISING GROUND WATER LEVELS, THE MAJORITY OF THE DATA DO NOT SUGGEST A RELATIONSHIP BETWEEN THE TWO FACTORS. THE COLUMN DESORPTION TEST DATA HAVE BEEN USED TO ESTIMATE THE DURATION OF AQUIFER CLEANUP IN TERMS OF PORE WATER VOLUMES EXTRACTED AS DISCUSSED IN SECTION 7.0.

#**IRM**

5.0 INTERIM REMEDIAL MEASURES

SINCE THE INITIATION OF INVESTIGATIONS AT THE CWP SITE, A NUMBER OF IMPROVEMENTS HAVE BEEN MADE TO THE FACILITIES AND SEVERAL INTERIM REMEDIAL MEASURES HAVE BEEN IMPLEMENTED. OVERALL IMPROVEMENTS TO THE CWP FACILITY INCLUDE EXTENSION OF THE AREA COVERED BY SURFACE PAVING, ERECTION OF CANOPIES OVER THE WOOD TREATMENT AREA, AND CONSTRUCTION OF BERMS TO DIVERT AND CONTROL SURFACE RUNOFF FROM TREATED WOOD STORAGE AREAS. SPECIFIC REMEDIAL MEASURES INCLUDE CONSTRUCTION OF A SLURRY CUTOFF WALL, INSTALLATION OF A GROUND WATER EXTRACTION TRENCH UPGRADIENT OF THE CUTOFF WALL, AND INSTALLATION OF A GROUND WATER EXTRACTION WELL NEAR THE RETORT AREA. EACH OF THESE MEASURES IS DESCRIBED IN THE FOLLOWING SECTIONS.

5.1 GENERAL FACILITY IMPROVEMENTS

IN RESPONSE TO RWQCB REQUESTS AND ON A VOLUNTARY BASIS, OVER THE PAST SEVERAL YEARS, CWP HAS IMPLEMENTED A NUMBER OF MEASURES TO REDUCE AND CONTROL SURFACE RUNOFF AND ELIMINATE THE SOURCE OF CHROMIUM TO SOIL AND GROUND WATER. THESE MEASURES HAVE INCLUDED GRADING AND CONSTRUCTION OF BERMS TO PREVENT SURFACE RUNOFF FROM THE RETORT AND TREATED WOOD STORAGE AREAS, SURFACE PAVING, AND THE CONSTRUCTION OF ROOFS OVER THE RETORT AREA. SURFACE GRADING AND BERM CONSTRUCTION WAS PERFORMED IN 1981 AND FOCUSED PRIMARILY ON THE RETORT AREA AND AREAS USED TO STORE TREATED WOOD. THE LOCATIONS OF THE BERMS ARE SHOWN IN FIGURE 2.

THE ASPHALT PAVING WAS EXTENDED TO THE NORTHERN AND SOUTHERN PORTIONS OF THE SITE IN 1979 AND 1981, RESPECTIVELY. THE AREAL EXTENT OF THE SURFACE PAVING IS SHOWN IN FIGURE 2. WITH THE EXCEPTION OF THE NARROW STRIP TO THE EAST OF THE SLURRY WALL, THE REMAINING UNPAVED AREAS, AS DEFINED IN FIGURE 2, WILL BE PAVED. THE PAVING SERVES TO REDUCE THE AMOUNT OF WATER SEEPING INTO THE SOIL AND POSSIBLY LEACHING CHROMIUM INTO GROUND WATER IN AREAS OF ELEVATED CHROMIUM CONCENTRATION. IN ADDITION, THE PAVING REDUCES THE LIKELIHOOD OF SPILLED WOOD PRESERVATIVES AND DRIPPINGS FROM TREATED WOOD DIRECTLY INFILTRATING THE SOIL. FORKLIFTS AND OTHER EQUIPMENT USED TO HANDLE TREATED WOOD ARE REQUIRED TO REMAIN IN CERTAIN AREAS TO AVOID TRACKING OF WOOD PRESERVING CHEMICALS TO AREAS WHERE SURFACE RUNOFF IS NOT CONTROLLED.

THREE LARGE ROOFS OR CANOPIES WERE ERECTED IN 1985 OVER THE RETORT AND ADJACENT AREA, AS SHOWN IN FIGURE 2. THESE COVERS PREVENT PRECIPITATION FROM FALLING DIRECTLY ONTO SURFACES WHERE WOOD PRESERVING CHEMICAL DRIPPINGS FROM TREATED WOOD MAY BE PRESENT. THE CLEAN RAIN WATER RUNNING OFF THESE ROOFS EVENTUALLY REPORTS TO SURFACE DRAINAGE DITCHES AROUND THE CWP FACILITY.

IT WAS OBSERVED THAT THE CONCRETE UTILITY BOX AROUND WELL CWP-10, LOCATED NEAR THE RETORT AREA, BECAME FILLED WITH WATER DURING HEAVY PRECIPITATION AT THE SITE. SAMPLES OF WATER FROM THE UTILITY BOX WERE COLLECTED AND ANALYZED. THE RESULTS INDICATED HIGH CHROMIUM CONCENTRATIONS. GROUND WATER SAMPLES FROM WELL CWP-10 HAD ALSO INDICATED A SUDDEN INCREASE IN CHROMIUM CONCENTRATIONS, FROM NONDETECTED TO RELATIVELY HIGH CONCENTRATIONS (APPENDIX B). IT WAS CONCLUDED THAT WELL CWP-10 WAS CONDUCTING CHROMIUM-CONTAINING SURFACE RUNOFF TO GROUND WATER. WELL CWP-10 WAS SUBSEQUENTLY ABANDONED BY GROUTING.

5.1.1 SLURRY WALL AND EXTRACTION TRENCH

IN OCTOBER 1983, CWP CONSTRUCTED A SLURRY CUTOFF WALL ALONG THE EASTERN SITE BOUNDARY. THE SLURRY WALL IS REPORTEDLY ABOUT 300 FEET LONG AND 20 FEET DEEP. CWP ALSO INSTALLED A GROUND WATER EXTRACTION TRENCH IMMEDIATELY TO THE WEST, HYDRAULICALLY UPGRADIENT OF THE SLURRY WALL. THE EXTRACTION TRENCH IS APPROXIMATELY 15 FEET-LONG, 18 FEET DEEP, AND 2 FEET WIDE. THE TRENCH IS GRAVEL-FILLED AND A 12-INCH DIAMETER EXTRACTION WELL, WELL HL-7, IS LOCATED APPROXIMATELY AT THE MID-POINT OF THE TRENCH. THE WELL CASING IS PERFORATED FROM 9 TO 19 FEET BELOW GRADE AND IS EQUIPPED WITH A PERMANENT, ELECTRIC SUBMERSIBLE PUMP. GROUND WATER EXTRACTED FROM THE TRENCH VIA WELL HL-7 IS USED DIRECTLY IN CWP'S WOOD PRESERVING OPERATIONS OR TRANSFERRED TO THE RECYCLED WATER TANK FOR SUBSEQUENT USE.

THE SLURRY WALL IS INTENDED TO INTERCEPT THE PLUME OF DISSOLVED CHROMIUM ORIGINATING NEAR THE RETORT AREA AND MIGRATING TO THE SOUTHWEST IN THE DIRECTION OF GROUND WATER FLOW. THE SLURRY WALL LOCATION AND CONFIGURATION WAS BASED ON THE KNOWN CHROMIUM PLUME AT THE TIME. THE EXTRACTION TRENCH AND WELL HL-7 ARE INTENDED TO REMOVE GROUND WATER IMPOUNDED BEHIND THE SLURRY WALL TO PREVENT FLOW AROUND THE NORTHERN AND SOUTHERN ENDS OF THE WALL. IT SHOULD BE NOTED THAT THE SLURRY WALL AND THE TRENCH WERE CONSTRUCTED BY CWP WITHOUT THE APPROVAL OF THE RWQCB AND WITHOUT PROFESSIONAL SUPERVISION.

5.2.1 RECYCLING/TREATMENT OF EXTRACTED GROUND WATER

IN THE DRIER SUMMER MONTHS, EXTRACTED GROUND WATER IS RECYCLED DIRECTLY INTO CWP'S WOOD PRESERVING OPERATIONS. IN THE WETTER WINTER MONTHS, WHEN A HIGHER RATE OF GROUND WATER EXTRACTION CAN BE ACHIEVED FROM WELL HL-7, THE EXTRACTED WATER THAT CANNOT BE UTILIZED IN CWP'S OPERATIONS COULD BE TREATED AND DISCHARGED, PROVIDED THE APPROPRIATE PERMITS ARE OBTAINED. GROUND WATER CAN BE TREATED USING THE EXISTING ELECTROCHEMICAL EQUIPMENT AT THE SITE. THE ELECTROCHEMICAL TREATMENT PROCESS PRODUCES EFFLUENT CONTAINING LESS THAN 0.05 MG/L OF DISSOLVED TOTAL CHROMIUM. THE OPERATION DETAILS OF THE ELECTROCHEMICAL UNIT ARE PROVIDED IN SECTION 7.2.4.

5.2.2 TREATED GROUND WATER DISPOSAL

AS MENTIONED ABOVE, EXCESS EXTRACTED GROUND WATER THAT CANNOT BE RECYCLED INTO WOOD PRESERVING OPERATIONS CAN BE TREATED BY ELECTROCHEMICAL PROCESS EQUIPMENT. CWP HAD PLANNED TO REINJECT THE TREATED GROUND WATER INTO THE WATER-BEARING ZONE VIA AN INJECTION WELL, WELL CWP-19, LOCATED TO THE WEST (HYDRAULICALLY UPGRADIENT) OF THE RETORT AREA.

WELL CWP-19 WAS INSTALLED IN AUGUST 1985 IN AN OPEN TRENCH (IT CORPORATION, SEPTEMBER 1985). THE TRENCH WAS EXCAVATED USING A BACKHOE AND IS 25 FEET LONG, 2.5 FEET WIDE, AND 14 FEET DEEP. AN 8-INCH DIAMETER, FLUSH-THREADED WELL CASING WAS THEN INSTALLED APPROXIMATELY IN THE CENTER OF THE TRENCH. THE WELL CASING IS PERFORATED FROM 6 TO 24 FEET BELOW GRADE. THE TRENCH WAS THEN BACKFILLED WITH WASHED PEA GRAVEL AND A SURFACE SEAL OF 5 FEET OF IMPORTED, MEDIUM-TEXTURED SOIL WAS PLACED AND COMPACTED.

ACCORDING TO CWP, INJECTION WELL CWP-19 HAS NOT BEEN EFFECTIVE IN ACCEPTING LARGE VOLUMES OF TREATED WATER, PARTICULARLY DURING THE WET, WINTER MONTHS WHEN GROUND WATER LEVELS ARE HIGH. THIS IS OF CONCERN AS THE VOLUME OF GROUND WATER EXTRACTED FROM WELLS CWP-18 AND HL-7 IS HIGHEST DURING THE WINTER MONTHS AND, CONSEQUENTLY, THE VOLUME OF WATER TO BE DISPOSED IS ALSO HIGHEST. AFTER EVALUATING THIS METHOD OF DISPOSAL OF TREATED GROUND WATER, INJECTION WAS JUDGED TO BE INAPPROPRIATE DURING THE WINTER MONTHS AND HIGH GROUND WATER LEVEL CONDITIONS. UNDER SUCH CONDITIONS, DISCHARGE IN THE UKIAH SANITARY SEWER SYSTEM SEEMS APPROPRIATE. DURING SUMMER MONTHS, HOWEVER, INJECTION INTO WELL CWP-19 MAY BE A FEASIBLE ALTERNATIVE, IF RECYCLING IS NOT POSSIBLE OR NEEDED.

5.2.3 OBSERVATION WELLS CWP-20 AND CWP-21

ON AUGUST 30, 1985, OBSERVATION WELLS CWP-20 AND CWP-21 WERE INSTALLED AT THE NORTHERN AND SOUTHERN ENDS, RESPECTIVELY, OF THE SLURRY CUTOFF WALL. THE LOCATIONS OF THESE WELLS ARE SHOWN IN FIGURE 2. THE PURPOSE OF THESE WELLS WAS TO ENABLE AN ASSESSMENT OF THE EFFECTIVENESS OF EXTRACTION FROM WELL HL-7 AND THE INTEGRITY OF THE SLURRY WALL.

WELLS CWP-20 AND CWP-21 WERE INSTALLED IN 8-INCH DIAMETER BORINGS DRILLED TO 23 AND 22 FEET, RESPECTIVELY. BOTH WELLS WERE COMPLETED WITH 2-INCH DIAMETER, FLUSH-THREADED PVC WELL CASINGS WITH 0.020-INCH, MACHINE-CUT SLOTS. WELL CWP-20 IS PERFORATED FROM 5 TO 23 FEET BELOW GRADE AND WELL CWP-21 FROM 5 TO 20 FEET. SAND PACKS OF NO. 3 GRADE SILICA SAND WERE INSTALLED TO ABOUT THE TOP OF THE PERFORATED INTERVAL. THE SCREENED ZONES WERE THEN SEALED WITH APPROXIMATELY 1 TO 1.3 FEET OF BENTONITE PELLETS AND GROUTED WITH CONCRETE UP TO THE GROUND SURFACE.

THE STRATIGRAPHY ENCOUNTERED DURING DRILLING INDICATES THAT NEITHER WELL INTERCEPTS THE MORE PERMEABLE ZONE 2, ALTHOUGH WELL CWP-21 APPARENTLY INTERCEPTS A SUBSTANTIAL GRAVEL LAYER BETWEEN 7.5 AND 14 FEET DEPTH. WELLS CWP-20 AND CWP-21 WERE USED AS OBSERVATION WELLS DURING EVALUATIONS OF THE EFFECTIVENESS OF THE SLURRY WALL AND EXTRACTION TRENCH.

5.2.4 PERFORMANCE EVALUATION

THE PERFORMANCE OF THE SLURRY WALL AND EXTRACTION TRENCH IN CONTAINING THE CHROMIUM PLUME AND REMEDIATING THE GROUND WATER HAS BEEN ASSESSED BY EVALUATING GROUND WATER QUALITY DATA AND BY A SERIES OF PUMPING TESTS.

GROUND WATER QUALITY DATA OBTAINED SINCE 1981 (TABLE B.2, APPENDIX B) DEMONSTRATE THAT THE INSTALLATION OF THE SLURRY CUTOFF WALL AND EXTRACTION OF GROUND WATER FROM WELL HL-7 HAVE RESULTED IN A REDUCTION IN CHROMIUM CONCENTRATIONS IN WELLS LOCATED HYDRAULICALLY DOWNGRADIENT OF THE SLURRY WALL. THE IMPROVEMENT IN GROUND WATER QUALITY SUBSEQUENT TO 1983 HAS BEEN DISCUSSED IN SECTION 4.5.3 THEREFORE, THESE INTERIM REMEDIAL MEASURES ARE BELIEVED TO HAVE BEEN EFFECTIVE IN REDUCING OFF-SITE MIGRATION.

TWO PUMPING TESTS WERE PERFORMED TO EVALUATE THE EFFECTIVENESS OF EXTRACTION FROM WELL HL-7 IN CONTAINING THE CHROMIUM PLUME AND TO ASSESS THE INTEGRITY OF THE SLURRY CUTOFF WALL. ONE TEST WAS PERFORMED IN FEBRUARY 1986, AND THE OTHER IN JULY 1986 WHEN WATER LEVELS WERE LOW. THE RESULTS OF THESE TESTS DEMONSTRATED THAT EXTRACTION FROM WELL HL-7 IS EFFECTIVE IN CONTAINING THE PLUME NEAR THE SOUTHERN END OF THE SLURRY WALL WHERE WELL CWP-21 IS LOCATED. THE RESULTS WERE NOT CONCLUSIVE IN DEMONSTRATING THAT HYDRAULIC CONTAINMENT OF THE PLUME IS ACHIEVED NEAR THE NORTHERN END OF THE SLURRY WALL. HOWEVER, WATER QUALITY DATA INDICATE THAT THERE IS NO PLUME MIGRATION IN THE ZONE INTERCEPTED BY WELL CWP-20 LOCATED AT THE NORTHERN END OF THE SLURRY CUTOFF WALL.

THE DETAILS OF THE PUMPING TESTS HAVE BEEN PRESENTED IN TECHNICAL REPORTS (GEOSYSTEM, MARCH 1986; GEOSYSTEM, SEPTEMBER 1986), COPIES OF WHICH HAVE BEEN SUBMITTED TO THE APPROPRIATE REGULATORY AGENCIES.

5.3 RETORT AREA RECOVERY WELL

ON AUGUST 29, 1985, A LARGE DIAMETER RECOVERY WELL, CWP-18, WAS INSTALLED IN THE RETORT AREA AT THE LOCATION SHOWN IN FIGURE 2. ALTHOUGH THE INSTALLATION OF THIS WELL HAS BEEN PREVIOUSLY REPORTED (IT CORPORATION, SEPTEMBER 25, 1985), A BRIEF DISCUSSION IS INCLUDED FOR COMPLETENESS.

WELL CWP-18 WAS INSTALLED IN A 36-INCH DIAMETER BORING, ADVANCED TO A TOTAL DEPTH OF 14 FEET AND INTERCEPTING ONLY ZONE 1. AN 8-INCH DIAMETER, FLUSH-THREADED WELL CASING WAS INSTALLED. THE CASING IS PERFORATED FROM 5 TO 14 FEET BELOW GRADE WITH 0.020-INCH, MACHINE CUT SLOTS. SAND PACK OF NO. 3 GRADE SILICA SAND WAS INSTALLED UP 6 FEET BELOW GRADE AND SEALED WITH 200 LBS OF 0.25-INCH BENTONITE PELLETS EMPLACED. THE REMAINING ANNULAR SPACE WAS CONCRETED TO THE GROUND SURFACE.

ON FEBRUARY 13, 1986, A SHORT DURATION PUMPING TEST WAS CONDUCTED (GEOSYSTEM, MARCH 1986). GROUND WATER LEVELS AT THE CWP SITE WERE AT OR VERY NEAR THE SEASONAL HIGH AT THIS TIME OF YEAR. WATER LEVELS WERE MEASURED IN THE PUMPING WELL AND IN NEARBY MONITORING WELL CWP-6. THE OBJECTIVE OF THIS PUMPING TEST WAS TO EVALUATE THE MAXIMUM YIELD OF WELL CWP-18 AND TO ESTIMATE THE HYDROGEOLOGIC CHARACTERISTICS OF ZONE 1 IN THE RETORT AREA.

THE PUMPING TEST DEMONSTRATED THAT WELL CWP-18 CAN BE EFFECTIVE IN REMOVING HIGHLY CONTAMINATED GROUND WATER FROM ZONE 1 IN THE RETORT AREA. EXTRACTION, HOWEVER, MUST BE AT A LOW, CONTINUOUS RATE, ON THE ORDER OF 0.5 TO 2.0 GPM, OR BY INTERMITTENT PUMPING AT A HIGHER DISCHARGE RATE. DURING THE DRY SEASON, WHEN GROUND WATER LEVELS IN ZONE 1 DROP SIGNIFICANTLY, WELL CWP-18 IS EXPECTED TO BE LESS EFFECTIVE.

CWP-18 IS NOT EXPECTED TO CONTAIN THE PLUME IN THE DOWNGRADIENT DIRECTION. HOWEVER, THIS PORTION OF THE PLUME SHOULD BE CAPTURED/CONTAINED BY EXTRACTION FROM WELL HL-7 AND THE SLURRY WALL.

#**RA**
RISK ASSESSMENT

THE PURPOSE OF THIS ASSESSMENT IS TO IDENTIFY AND ASSESS THE POTENTIAL MIGRATION PATHWAYS AND EXPOSURE MECHANISMS BY WHICH CONTAMINANTS IN SOIL AND GROUND WATER IN THE STUDY AREA MAY CAUSE POSSIBLE HEALTH RISKS AND ADVERSE ENVIRONMENTAL IMPACTS. THE INFORMATION PRESENTED IN THIS SECTION CORRESPONDS TO THE REQUIREMENTS OF SECTIONS 5 AND 6 OF THE RAP GUIDELINES.

SYSTEMATIC RISK ASSESSMENT INCLUDES SITE CHARACTERIZATION, HAZARD IDENTIFICATION, AND FATE

ANALYSIS. THE SITE HAS BEEN CHARACTERIZED BY A NUMBER OF INVESTIGATIONS, THE RESULTS OF WHICH ARE SUMMARIZED IN SECTION 4.0. HAZARD IDENTIFICATION IS PERFORMED BY ESTABLISHING THE PRIMARY CONTAMINANTS OR INDICATOR PARAMETERS AND, BASED ON AVAILABLE DATA, EVALUATING THE LEVEL OF HAZARD TO HUMAN HEALTH AND THE ENVIRONMENT. CHROMIUM AND ARSENIC HAVE BEEN SELECTED AS THE INDICATOR PARAMETERS BASED ON THEIR OCCURRENCE IN SOIL AND GROUND WATER, THEIR GEOCHEMICAL BEHAVIOR, AND THEIR TOXICITY. ACCORDINGLY, THE RISK ASSESSMENT PRESENTED HEREIN HAS BEEN PERFORMED FOR THESE COMPOUNDS. FATE ANALYSIS CONSIDERS MIGRATION PATHWAYS IN ORDER TO IDENTIFY THE POTENTIAL EXPOSURE OF CONTAMINANTS TO RECEPTORS.

BASED ON THE ABOVE, THE RISK ASSESSMENT INCLUDES AN EVALUATION OF POTENTIAL MIGRATION PATHWAYS, DOCUMENTATION OF TOXICITY, A DESCRIPTION OF THE POPULATION POTENTIALLY AT RISK, AN EXPOSURE ASSESSMENT, AND A DESCRIPTION OF RISK CHARACTERISTICS. THE EMPHASIS IN THIS ASSESSMENT HAS BEEN PLACED ON HEALTH RATHER THAN ECOLOGICAL IMPACTS. ALSO, BECAUSE OF CURRENT ZONING AND THE EXPECTED INDUSTRIAL USE SUBSEQUENT TO SITE CLOSURE, THE RESULTS OF THE RISK ASSESSMENT ARE BELIEVED TO BE APPLICABLE TO POST-CLOSURE CONDITIONS.

MIGRATION PATHWAYS

POTENTIAL MIGRATION PATHWAYS INCLUDE AIRBORNE PARTICULATE MATTER AND DIRECT EXPOSURE TO SOIL, SURFACE WATER, AND GROUND WATER. EACH OF THESE PATHWAYS IS ADDRESSED BELOW.

6.1.1 MIGRATION THROUGH AIR

POTENTIAL SOURCES OF CHROMIUM, ARSENIC, AND COPPER IN THE AIR INCLUDE CONTAMINATED SOIL AND CWP'S WOOD PRESERVING OPERATIONS. MONITORING OF AIR EMISSIONS FROM CWP'S WOOD PRESERVING PROCESS HAS BEEN PERFORMED PERIODICALLY; HOWEVER EVALUATION OF THE RESULTING AIR QUALITY DATA IS NOT WITHIN THE SCOPE OF THIS RAP.

CONTAMINATED SOIL EXPOSED TO THE ATMOSPHERE MAY DRY AND SOIL PARTICLES CAN ENTER THE ATMOSPHERE AS DUST. THUS, CHROMIUM, ARSENIC, AND COPPER COULD BE CARRIED BY SOIL PARTICLES AND DISPERSED INTO THE ATMOSPHERE ACCORDING TO THE PREVAILING CLIMATIC CONDITIONS. AS POINTED OUT IN SECTION 5.1, HOWEVER, ESSENTIALLY ALL AREAS WHERE NEAR-SURFACE SOILS ARE KNOWN TO CONTAIN ELEVATED CONCENTRATIONS OF CHROMIUM, ARSENIC, AND COPPER HAVE BEEN PAVED. THEREFORE, THERE IS NOT BELIEVED TO BE A SIGNIFICANT POTENTIAL FOR CHROMIUM, ARSENIC, AND COPPER FROM ON-SITE SURFACE SOILS TO MIGRATE THROUGH AIR. SOILS WITH BACKGROUND CONCENTRATIONS OF CHROMIUM, ARSENIC, AND COPPER IN THE STUDY AREA COULD INTRODUCE THESE CONSTITUENTS INTO THE ATMOSPHERE, BUT AT INSIGNIFICANT LEVELS.

NO SITE-SPECIFIC BACKGROUND AIR QUALITY MONITORING DATA ARE AVAILABLE; HOWEVER, THE CONCENTRATIONS OF TOTAL CHROMIUM MEASURED IN AMBIENT AIR IN MANY URBAN AND NON-URBAN AREAS OF THE UNITED STATES, FROM 1977 TO 1980, HAVE BEEN DOCUMENTED (US EPA, AUGUST 1984). THE CONCENTRATIONS RANGE FROM LESS THAN 0.0060 MG/M3 TO GREATER THAN 0.6000 MG/M3. THE MEAN CHROMIUM CONCENTRATIONS IN NON-URBAN, BACKGROUND AREAS SUCH AS NATIONAL PARKS RANGED FROM 0.0052 MG/M3 TO 0.0090 MG/M3 OVER THE 1977 TO 1980 PERIOD. SELECTED DATA CONSIDERED TO BE REPRESENTATIVE OF THE RANGE OF TOTAL CHROMIUM CONCENTRATIONS IN AIR, HAVE BEEN SUMMARIZED IN TABLE 8.

IN SUMMARY, UNDER NORMAL CONDITIONS, THERE IS NOT BELIEVED TO BE A SIGNIFICANT CONTRIBUTION OF CHROMIUM, ARSENIC, AND COPPER TO THE ATMOSPHERE THROUGH THE RESIDUAL CONTAMINATED SOIL AT THE SITE. EXCAVATION AND REMOVAL OR OTHER SOIL DISTURBANCE MAY, HOWEVER, PROVIDE A POTENTIAL AIR PATHWAY. THIS PATHWAY WOULD REQUIRE A DETAILED EVALUATION IF EXCAVATION/REMOVAL WERE TO BE SELECTED AS A REMEDIAL ALTERNATIVE OR IF SOME OTHER SOIL DISTURBANCE OCCURRED. THE EVALUATION WOULD INCLUDE AIR MONITORING AND COMPARISON OF THE RESULTING DATA WITH BACKGROUND CONCENTRATIONS FOR HAZARD DETERMINATION.

6.1.2 DIRECT EXPOSURE

THE MOST DIRECT PATHWAY FOR CHROMIUM, COPPER, AND ARSENIC TO IMPACT HUMAN HEALTH AND THE ENVIRONMENT IS THROUGH CONTACT WITH CONTAMINATED SOIL. AS DESCRIBED IN SECTION 5.1, TEE AREAS WHERE NEAR-SURFACE SOILS ARE KNOWN TO HAVE BEEN IMPACTED ARE PAVED WITH ASPHALT OR CONCRETE. DIRECT EXPOSURE WOULD BE LIKELY ONLY IF THESE SOILS WERE EXCAVATED OR DISTURBED. THUS, SUCH EXPOSURES WOULD MOST LIKELY OCCUR DURING THE CLOSURE OF THE PLANT AND THE SUBSEQUENT REMEDIATION OF THE SITE.

ACCORDING TO TESTS PERFORMED ON SOIL SAMPLES COLLECTED IN THE STUDY AREA, THE BACKGROUND CONCENTRATIONS OF CHROMIUM, ARSENIC, AND COPPER ARE LESS THAN 50, 14, AND 20 MG/KG, RESPECTIVELY (TABLE D-1, APPENDIX D). FOR COMPARISON, CHROMIUM CONCENTRATIONS IN SOILS AT SELECTED LOCATIONS IN THE UNITED STATES ARE SUMMARIZED IN TABLE 9. THE CONCENTRATION OF CHROMIUM IN SOIL VARIES ACCORDING TO ITS ORIGIN. COMPARING THE CHROMIUM CONCENTRATIONS OF SURFACE SOILS AT THE CWP SITE WITH CONCENTRATIONS PRESENTED IN TABLE 9, SITE BACKGROUND CONCENTRATIONS ARE NEAR THE UPPER BOUNDARY OF THE RANGE OF MEDIAN CONCENTRATIONS MEASURED AT THE SELECTED LOCATIONS.

6.1.3 MIGRATION THROUGH SURFACE WATER

POTENTIAL SURFACE WATER MIGRATION PATHWAYS INCLUDE SHEET FLOW OVER THE SITE AND CHANNEL FLOW IN THE SURFACE DRAINS. RUNOFF FROM THE SITE IS COLLECTED IN UNLINED DITCHES AROUND THE PERIMETER OF THE SITE. THE DITCHES EVENTUALLY DISCHARGE INTO THE RUSSIAN RIVER, ALSO THROUGH UNLINED DITCHES. SURFACE RUNOFF FROM THE TREATED WOOD STORAGE AND RETORT AREAS IS COLLECTED IN A SUMP AND RECYCLED INTO CWP'S WOOD PRESERVING OPERATIONS.

ACCORDING TO RWQCB STAFF, FLOW IN THE SURFACE DRAINS MAY BE CONTINUOUS DURING THE WINTER MONTHS DUE TO THE INFLOW OF GROUND WATER. ALSO, DURING PERIODS OF HIGH PRECIPITATION, THE WATER LEVELS IN THE DITCHES RISE TO NEAR THE SURROUNDING LAND SURFACE. OBSERVATIONS MADE BY CWP PERSONNEL INDICATE THAT INTENSE PRECIPITATION RESULTS IN FLOW IN ALL SURFACE DRAINS SURROUNDING THE SITE. DURING LIGHT RAINFALL, HOWEVER, STORM WATER RAPIDLY INFILTRATES INTO THE VALLEY FILL THROUGH THE UNLINED DITCHES AND NO FLOW IS RECORDED AT STATION C-100 (FIGURE 2).

IN ACCORDANCE WITH RWQCB REQUIREMENTS, CWP PERSONNEL PERIODICALLY MONITOR STORM WATER QUALITY DURING PRECIPITATION EVENTS OF SUFFICIENT INTENSITY AND DURATION TO CAUSE FLOW IN THE DITCHES AROUND THE SITE. THE RESULTS OF STORM WATER QUALITY MONITORING ARE PRESENTED IN APPENDIX C. THE HIGHEST RECORDED CONCENTRATIONS WERE 0.630 MG/L AND 0.790 MG/L FOR CR(VI) AND TOTAL CHROMIUM, RESPECTIVELY, ON MARCH 13, 1984. RECENT STORM WATER QUALITY DATA HAVE INDICATED CHROMIUM CONCENTRATIONS TO BE AT OR BELOW THE DRINKING WATER STANDARD OF 0.05 MG/L ON ALL BUT A FEW OCCASIONS. RECENT STORM WATER MONITORING DATA FOR MONITORING STATIONS NE, NW, AND C-100 SHOW THAT CONCENTRATIONS OF CHROMIUM AND ARSENIC WERE LESS THAN 0.02 AND 0.004 MG/L, RESPECTIVELY WHICH DETECTION LIMITS FOR THE COMPOUNDS TESTED (GEOSYSTEM, APRIL 1989) A SUMMARY OF WATER QUALITY CRITERIA IS PRESENTED IN TABLE 10.

6.1.4 MIGRATION THROUGH GROUND WATER

THE MOST PROBABLE PATHWAY FOR CHEMICAL MIGRATION FROM THE CWP SITE IS VIA GROUND WATER. THE DATA REPRESENTING THE JANUARY 1988 (FIGURE 14) CONDITIONS INDICATE THAT ELEVATED CHROMIUM CONCENTRATIONS ARE DETECTED PRIMARILY ON SITE, TO THE WEST AND HYDRAULICALLY UPGRADIENT OF THE SLURRY CUTOFF WALL. THE ISOCONCENTRATION LINES REPRESENT THE AREAL EXTENT OF CHROMIUM CONTAMINATION IN THE UPPERMOST WATER-BEARING ZONE, ZONE 1. BECAUSE OF THE SOUTHEASTERLY FLOW DIRECTION, THE DISSOLVED CHROMIUM COMPOUNDS HAVE A TENDENCY TO MIGRATE IN THE SAME DIRECTION, TOWARD THE SLURRY WALL. THE CONCENTRATIONS, HOWEVER, DECREASE WITH DISTANCE FROM THE RETORT AREA.

THE RATE OF MIGRATION OF CHROMIUM IN ON-SITE AREAS DEPENDS PRIMARILY ON THE SEEPAGE VELOCITY OF GROUND WATER AND SORPTION CHARACTERISTICS OF CHROMIUM. PREVIOUS ANALYSES (IT CORPORATION, JUNE 1985) HAVE INDICATED THAT THE MIGRATION RATE OF THE CHROMIUM FRONT AT THE SITE IS ABOUT 58 FEET PER YEAR. IN THIS ESTIMATION, THE LOWEST RETARDATION FACTOR, REPRESENTING THE LOWEST DISTRIBUTION COEFFICIENT, WAS USED TO PROVIDE A CONSERVATIVE ANALYSIS. A CONSERVATIVE ANALYSIS IN THIS CASE IS ONE RESULTING IN LARGER MIGRATION RATES AND HIGHER DOWNGRADIENT CONCENTRATIONS. THE ANALYSIS IS ALSO CONSERVATIVE BECAUSE GROUND WATER FLOW AND CHROMIUM TRANSPORT WERE ASSUMED TO BE ONE-DIMENSIONAL. ALTHOUGH THE FLOW MAY BE UNIFORM AND REPRESENTED ONE-DIMENSIONALLY, CHROMIUM TRANSPORT IS TWO-DIMENSIONAL.

HYDRAULIC AND GROUND WATER QUALITY DATA, OBTAINED FROM PUMPING TESTS AND REGULAR GROUND WATER MONITORING, INDICATE THAT THE CHROMIUM FRONT IS INTERCEPTED BY THE SLURRY WALL. WATER IMPOUNDED BEHIND THE SLURRY WALL IS THEN EXTRACTED VIA WELL HL-7. IT IS NOTED THAT WITHOUT SOME FORM OF HYDRAULIC CONTROL, IN THIS CASE GROUND WATER EXTRACTION, IMPOUNDED WATER WOULD EVENTUALLY FLOW AROUND AND BENEATH THE SLURRY WALL AND CHROMIUM WOULD CONTINUE TO MIGRATE IN THE DOWNGRADIENT DIRECTION. CONSTRUCTION OF THE SLURRY WALL AND EXTRACTION FROM WELL HL-7 HAVE SUBSTANTIALLY REDUCED DISSOLVED CHROMIUM CONCENTRATIONS IN OFF-SITE AREAS.

THE PRESENCE OF CHROMIUM IN OFF-SITE AREAS IS BELIEVED TO HAVE RESULTED PRIMARILY FROM MIGRATION PRIOR TO CONSTRUCTION OF THE SLURRY WALL IN OCTOBER 1983. SINCE THEN, THE CONCENTRATIONS OF CHROMIUM IN OFF-SITE WELLS HAVE GRADUALLY DECREASED, AS DISCUSSED IN SECTION 4.5.3. GROUND WATER QUALITY DATA FROM OFF-SITE WELLS, OBTAINED IN JANUARY 1988, SHOW THAT CHROMIUM CONCENTRATIONS WERE BELOW THE DRINKING WATER STANDARD OF 0.05 MG/L. ALTHOUGH CHROMIUM CONCENTRATIONS IN WELL AT-2, LOCATED IN THE PEAR ORCHARD, HAVE OCCASIONALLY EXCEEDED THE DRINKING WATER STANDARD, THE DATA REPRESENTING 1989 CONDITIONS SHOW LESS THAN 0.05 MG/L AND GENERALLY LESS THAN THE DETECTION LIMIT OF 0.02 MG/L.

THE GROUND WATER QUALITY DATA INDICATE THAT BECAUSE OF THE OVERALL SITE IMPROVEMENTS AND THE INTERIM REMEDIAL MEASURES IMPLEMENTED, OFF-SITE MIGRATION IS LIMITED. TO ADDRESS POTENTIAL OFF-SITE MIGRATION FOR RISK ASSESSMENT PURPOSES, HOWEVER, A TWO-DIMENSIONAL AREAL MODEL HAS BEEN USED. DETAILS OF THIS MODELING EFFORT ARE PRESENTED IN APPENDIX E. THE MODEL HAS BEEN USED TO PREDICT THE DOWNGRADIENT DISTRIBUTION OF CHROMIUM UNDER UNIFORM FLOW CONDITIONS CONSIDERING VARIOUS MANAGEMENT PRACTICES. THE MODEL RESULTS HAVE SHOWN THE FOLLOWING:

- OF THE PREDICTED CHROMIUM CONCENTRATIONS ARE LESS THAN 0.05 MG/L AT A DISTANCE OF ABOUT 250 METERS (820 FEET) TO THE SOUTHEAST OF THE SLURRY WALL. THIS DISTANCE CORRESPONDS APPROXIMATELY TO THE LOCATION OF WELL AT-5. CHROMIUM HAS NOT BEEN DETECTED IN THIS WELL SINCE ITS INSTALLATION IN DECEMBER 1986.

- THE PREDICTED CHROMIUM CONCENTRATIONS AT OTHER RECEPTORS BEYOND WELL AT-5 ARE BELOW THE DETECTION LIMIT OF 0.02 MG/L.

- AN INCREASE IN THE CHROMIUM CONCENTRATION IN THE ASSUMED SOURCE AREA (NEAR WELL CWP-8), TO ABOUT 1 MG/L FOR SHORT DURATIONS, WILL NOT RESULT IN CHROMIUM CONCENTRATIONS HIGHER THAN 0.05 MG/L AT THE NEAREST RECEPTOR.

THE MODEL RESULTS INDICATE THAT FLUCTUATIONS IN CHROMIUM CONCENTRATIONS IN THE ASSUMED SOURCE AREA (PRIMARILY WELL CWP-8), WITHIN THE RANGE OBSERVED SINCE SLURRY WALL CONSTRUCTION, WILL NOT RESULT IN CHROMIUM CONCENTRATIONS HIGHER THAN DRINKING WATER STANDARDS IN THE NEARBY RECEPTORS. OFF-SITE CONTAMINATION IS LIKELY ONLY IF HIGH CHROMIUM CONCENTRATIONS ARE ALLOWED TO MIGRATE BEYOND THE SLURRY WALL AND PERSIST FOR A LONG DURATION. HOWEVER, MODEL SIMULATIONS (APPENDIX E) HAVE SHOWN THAT IF THE CONCENTRATIONS OF CHROMIUM AT WELL CWP-8 REMAIN AT ABOUT 1 MG/L FOR FOUR YEARS, DOWNGRADIENT CONCENTRATION AT ABOUT 820 FEET FROM WELL CWP-8 MAY APPROACH 0.05 MG/L.

6.2 OCCURRENCE, INTAKE, AND TOXICITY CHARACTERISTICS OF CHROMIUM AND ARSENIC

CHROMIUM, COPPER, AND ARSENIC ARE ELEMENTS WHICH ARE FOUND NATURALLY IN FOOD, WATER, AND AIR. EXPOSURE OF HUMAN BEINGS TO THESE ELEMENTS AT LEVELS WHICH EXCEED NATURAL CONCENTRATIONS MAY LEAD TO ADVERSE HEALTH EFFECTS. BASED ON THE OCCURRENCE OF METALS AT THE SITE, THEIR CONCENTRATIONS AND RELATIVE TOXICITY, THE SUBJECT EVALUATION PERTAINS ONLY TO CHROMIUM AND ARSENIC. DETAILS RELATED TO THE OCCURRENCE, INTAKE MECHANISMS, AND TOXICITY CHARACTERISTICS OF CHROMIUM AND ARSENIC ARE PRESENTED IN APPENDIX F.

6.3 PUBLIC HEALTH AND POPULATION DENSITY

THIS SECTION SUMMARIZES THE INFORMATION RELATED TO PUBLIC HEALTH PROTECTION GOALS AND POPULATION POTENTIALLY AT RISK.

6.3.1 PUBLIC HEALTH PROTECTION STANDARDS

PUBLIC HEALTH PROTECTION GOALS ARE ESTABLISHED BY PUBLIC HEALTH AND REGULATORY AGENCIES. RECOMMENDED OR ESTABLISHED STANDARDS FOR CHROMIUM IN THE UNITED STATES ARE SUMMARIZED IN TABLE 11. FOR PROTECTION OF HUMAN HEALTH FROM THE TOXIC PROPERTIES OF CR(III) INGESTED THROUGH WATER AND CONTAMINATED AQUATIC ORGANISMS, THE AMBIENT WATER CRITERION HAS BEEN DETERMINED TO BE 170 UG/L. FOR PROTECTION OF HUMAN HEALTH FROM THE TOXIC PROPERTIES OF CR(III) INGESTED THROUGH CONTAMINATED AQUATIC ORGANISMS ALONE, THE AMBIENT WATER CRITERION HAS BEEN DETERMINED TO BE 3,433 UG/L. THE AMBIENT WATER QUALITY CRITERION FOR TOTAL CR(VI) IS RECOMMENDED TO BE IDENTICAL TO THE EXISTING DRINKING WATER STANDARD, WHICH IS 0.05 MG/L.

6.3.2 POPULATION POTENTIALLY AT RISK

USING POPULATION DENSITY STATISTICS (GREATER UKIAH CHAMBER OF COMMERCE, JUNE 1987) AND THE RESULTS OF A SURVEY AND INTERVIEWS BY GEOSYSTEM PERSONNEL, THE ESTIMATED NUMBER OF PEOPLE LIVING IN THE STUDY AREA WITHIN ONE-HALF MILE FROM THE SITE VARIES SEASONALLY FROM ABOUT 20 TO 100. THIS POPULATION IS POTENTIALLY AT RISK IN RELATION TO SURFACE WATER AND GROUND WATER MIGRATION PATHWAYS. THE POPULATION DISTRIBUTION AROUND THE SITE IS ADDRESSED IN MORE DETAIL IN SECTION 3.2.4.

6.4 EXPOSE ASSESSMENT AND RISK CHARACTERIZATION

BASED ON THE EVALUATION OF POTENTIAL MIGRATION PATHWAYS AND THE POPULATION POTENTIALLY AT RISK, AN EXPOSURE ASSESSMENT HAS BEEN PERFORMED AND THE RISK ASSOCIATED WITH THE EXPOSURE CHARACTERIZED.

6.4.1 POTENTIAL EXPOSURE THROUGH AIR

WITH MAINTENANCE OF A CAP OR IMPLEMENTATION OF A PERMANENT SOIL REMEDY, THERE IS NO SIGNIFICANT EXPOSURE TO CHROMIUM, ARSENIC, AND COPPER THROUGH AIR. SINCE THERE IS NO SIGNIFICANT EXPOSURE, THE RISK OF ADVERSE HEALTH EFFECTS ASSOCIATED WITH MIGRATION OF CHROMIUM THROUGH AIR IS BELIEVED TO BE INSIGNIFICANT.

6.4.2 POTENTIAL EXPOSURE THROUGH DIRECT CONTACT WITH SOIL

AS DESCRIBED IN SECTION 6.1.2, BECAUSE OF SURFACE PAVING OVER SOILS CONTAINING ELEVATED CHROMIUM CONCENTRATIONS, THERE IS NO DIRECT EXPOSURE TO CONTAMINATED SOIL. THEREFORE, THERE IS NO RISK OF ADVERSE HEALTH EFFECTS ASSOCIATED WITH THIS PATHWAY UNDER PRESENT CONDITIONS. HOWEVER, DURING POST-CLOSURE SOIL REMEDIATION, POTENTIAL EXPOSURE IS LIKELY. SUCH EXPOSURE MUST BE ADDRESSED BY IMPLEMENTATION OF AN APPROPRIATE HEALTH AND SAFETY PLAN.

6.4.3 POTENTIAL EXPOSURE THROUGH SURFACE WATER

STORM WATER RUNOFF ORIGINATING FROM THE SITE IS SUBJECT TO INFILTRATION AND DILUTION BY DOWNSTREAM FLOWS. POTENTIAL EXPOSURE MECHANISMS, THEREFORE, INCLUDE EXPOSURE TO GROUND WATER RECHARGED BY INFILTRATING SURFACE WATERS AND DIRECT EXPOSURE TO CONTAMINATED SURFACE WATER. THE FIRST EXPOSURE MECHANISM IS BELIEVED TO BE INSIGNIFICANT BECAUSE OF THE INTERMITTENT NATURE OF THE RUNOFF AND ATTENUATION OF CHROMIUM AND ARSENIC CONCENTRATIONS DURING DOWNWARD PERCOLATION. THE SECOND EXPOSURE MECHANISM MUST CONSIDER THE IMPACT OF DILUTION ON CHROMIUM CONCENTRATIONS WITHIN THE SURFACE DRAINAGE DITCHES.

SITE IMPROVEMENTS AND IMPLEMENTATION OF SURFACE RUNOFF CONTROL MEASURES HAVE REDUCED THE CONCENTRATION OF CHROMIUM AT THE COMPLIANCE POINT (MONITORING STATION C-100) TO ACCEPTABLE LEVELS (LESS THAN 0.05 MG/L). ADDITIONAL SURFACE WATER CONTROLS, IDENTIFIED IN SECTION 7.2.1, SHALL BE IMPLEMENTED TO FURTHER REDUCE THE EXPOSURE THROUGH SURFACE WATER. THE MOST RECENT DATA HAVE SHOWN LESS THAN 0.32 MG/L AND 0.004 MG/L CONCENTRATIONS FOR CHROMIUM AND ARSENIC, RESPECTIVELY, AT STATION C-100. UNDER SUCH CIRCUMSTANCES, THE POTENTIAL EXPOSURE OF BIOLOGICAL RECEPTORS IN DOWNSTREAM DITCHES AND STREAMS IS NEGLIGIBLE.

ALTHOUGH NO FLOW MEASUREMENTS HAVE BEEN MADE IN THE DITCHES DOWNSTREAM OF THE CWP SITE, BASED ON FIELD OBSERVATIONS, AN APPROXIMATE DILUTION FACTOR CAN BE CALCULATED. ACCORDING TO CWP, THE FLOW RATE AT MONITORING STATION C-100 IS TWICE THAT AT STATION NE DUE TO THE CONTRIBUTION FROM OTHER CULVERTS AND STREAMS. AS SHOWN BELOW, A COMPARISON OF WATER QUALITY DATA BETWEEN THESE TWO MONITORING STATIONS SUPPORTS THE ABOVE OBSERVATION.

CHROMIUM CONCENTRATION (MG/1)

DATE	MONITORING STATION NE	MONITORING STATION C-100
APRIL 6, 1986	0.14	0.09
MARCH 5, 1987	0.06	0.03

THE ABOVE DATA SHOW THAT THE CHROMIUM CONCENTRATIONS AT MONITORING STATION C-100 ARE ABOUT 50 PERCENT OF THOSE DETECTED AT MONITORING STATION NE. THE DISTANCE BETWEEN MONITORING STATIONS NE AND C-100 IS ABOUT 550 FEET. IT IS EVIDENT THAT IF FLOW RATES INCREASE AT SUCH PROPORTIONS IN THE DOWNSTREAM DIRECTION AND NO CHROMIUM IS INTRODUCED ALONG THE FLOW PATH, THE CHROMIUM CONCENTRATION WILL NOT EXCEED 0.05 MG/L WITHIN A SHORT DISTANCE FROM MONITORING STATION C-100, IF WASTE DISCHARGE REQUIREMENTS ARE OBSERVED. UNDER SUCH CONDITIONS, THE IMPACT OF CHROMIUM ON DOWNSTREAM RECEPTORS WOULD BE INSIGNIFICANT. TO PROVIDE A MORE QUANTITATIVE ASSESSMENT OF RISK, FLOW RATES MUST BE KNOWN TO ESTIMATE THE DILUTION FACTORS AND THE CONSEQUENT POTENTIAL IMPACT.

THE MINIMUM FLOW IN THE RUSSIAN RIVER IS MAINTAINED AT 150 CFS (DWR, MAY 1980) UNDER INTENSE RAINFALL CONDITIONS, WHEN STORM WATER FLOWS TO THE RUSSIAN RIVER, THE VOLUME ORIGINATING FROM THE SITE IS ASSUMED TO BE 1 PERCENT OF THE FLOW IN THE RIVER. WITH SUCH AN ASSUMPTION, A DILUTION FACTOR OF 100 WOULD BE APPLICABLE FOR CALCULATING THE CHROMIUM CONCENTRATIONS IN THE RIVER. THEREFORE, THE STORM WATER EVENTS, WITH HISTORICAL CONCENTRATIONS OF CHROMIUM, ARE NOT LIKELY TO HAVE AN ADVERSE IMPACT ON SURFACE WATER QUALITY IN THE RUSSIAN RIVER. A MAXIMUM CONCENTRATION OF 0.63 MG/L (APPENDIX C) AT THE SITE WOULD RESULT IN A CONCENTRATION OF 0.0064 MG/L IN THE RIVER. THUS, THE RISK ASSOCIATED WITH THIS POTENTIAL EXPOSURE IS INSIGNIFICANT.

6.4.4 POTENTIAL EXPOSURE THROUGH GROUND WATER

POTENTIAL EXPOSURE THROUGH GROUND WATER HAS BEEN EVALUATED CONSIDERING ON-SITE AND OFF-SITE AREAS SEPARATELY. POTENTIAL EXPOSURE TO ON-SITE GROUND WATER WILL ONLY BE POSSIBLE DURING MONITORING OR ACTIVITIES RELATED TO GROUND WATER EXTRACTION AND TREATMENT. THIS EXPOSURE POTENTIAL MUST BE ELIMINATED BY FOLLOWING THE APPROPRIATE HEALTH AND SAFETY MEASURES AND OTHER STANDARD PROCEDURES OUTLINED IN THIS RAP, THE STORM WATER/GROUND WATER MONITORING PROTOCOL, AND OTHER PERTINENT DOCUMENTS. AS THERE ARE NO ON-SITE WELLS PRODUCING WATER FROM THE CONTAMINATED ZONE, THERE IS NO EXPOSURE AND, THUS, NO RISK.

AS DESCRIBED IN SECTION 4.5.3, THE CURRENT UNDERSTANDING OF OFFSITE GROUND WATER QUALITY CONDITIONS INDICATES THAT CR(VI) CONCENTRATIONS ARE BELOW THE DRINKING WATER STANDARD OF 0.05 MG/L. NO WATER-PRODUCING WELLS ARE KNOWN TO EXIST IN AREAS WHERE HISTORIC CHROMIUM CONCENTRATIONS HAVE EXCEEDED THE 0.05 MG/L DRINKING WATER STANDARD. AT THE PRESENT TIME, THEREFORE, THERE IS NOT BELIEVED TO BE A SIGNIFICANT POTENTIAL FOR EXPOSURE THROUGH THIS MIGRATION PATHWAY THIS CONDITION IS EXPECTED TO PERSIST AS LONG AS ON-SITE EXTRACTION FROM WELL HL-7 AND OTHER REMEDIATION MEASURES ARE IN EFFECT.

FAILURE TO CONTAIN THE CHROMIUM PLUME ON SITE COULD RESULT IN THE INTRODUCTION OF CHROMIUM TO GROUND WATER IMMEDIATELY TO THE EAST (DOWNGRADIENT) OF THE SLURRY CUTOFF WALL. THE IMPACT ON DOWNGRADIENT RECEPTORS WILL DEPEND ON THE CONCENTRATION AND PERSISTENCE OF THE SOURCE, AS DEMONSTRATED BY THE TRANSPORT MODEL (APPENDIX E). FOR INSTANCE, AN INITIAL CONCENTRATION OF 1 MG/L IN GROUND WATER TO THE EAST OF THE SLURRY CUTOFF WALL, WITH A SOURCE REDUCTION RATE OF 0.0063 PER DAY, WOULD RESULT IN A CONCENTRATION OF LESS THAN 0.00068 MG/1 AT ABOUT 820 FEET FROM THE SITE. THIS CONCENTRATION IS ABOUT TWO ORDERS OF MAGNITUDE LOWER THAN THE DRINKING WATER STANDARD OF 0.05 MG/L. HOWEVER, PERSISTENCE OF THE 1 MG/L CONCENTRATION MAY RESULT IN GRADUAL DEGRADATION OF WATER QUALITY IN DOWNGRADIENT AREAS. AS MENTIONED IN SECTION 6.1.4, PERSISTENCE OF A 1 MG/L CHROMIUM CONCENTRATION FOR FOUR YEARS AT WELL CWP-8 MAY CAUSE AN INCREASE IN CHROMIUM CONCENTRATIONS TO 0.05 MG/L AT A DISTANCE OF 820 FEET DOWNGRADIENT. TO ELIMINATE THIS POTENTIAL SITUATION, THE RECOMMENDED REMEDIAL ACTION INCLUDES HYDRAULIC CONTROL MEASURES AT WELL CWP-8 (SECTION 7.0). EXTRACTION FROM WELL CWP-8 WOULD CONTAIN THE CHROMIUM PLUME IN THE VICINITY AND WOULD ELIMINATE THE POTENTIAL FOR FURTHER DOWNGRADIENT MIGRATION.

AS MENTIONED IN SECTION 7.0, A CONTINGENCY PLAN HAS BEEN DEVELOPED FOR POSSIBLE OFF-SITE REMEDIATION. THE PLAN WILL BE IMPLEMENTED SUBSEQUENT TO THE REGULATORY AGENCIES' DECISION REGARDING THE CRITERIA FOR INITIATION OF OFF-SITE REMEDIATION. THE CRITERIA WOULD INCLUDE A PRESCRIBED CHROMIUM CONCENTRATION PERSISTING FOR A GIVEN TIME PERIOD. IMPLEMENTATION OF THE CONTINGENCY PLAN WILL PROVIDE ADDITIONAL CONTROL TO PREVENT FURTHER DOWNGRADIENT MIGRATION.

BASED ON THE ABOVE CONSIDERATIONS, IT IS CONCLUDED THAT UNDER PRESENT CONDITIONS AND WITH CONTINUED ON-SITE REMEDIATION, THERE IS NO POTENTIAL EXPOSURE TO CHROMIUM THROUGH GROUND WATER. THEREFORE, THERE IS NO HEALTH RISK ASSOCIATED WITH THIS PATHWAY.

#ERA

7.0 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

THE PURPOSE OF EVALUATING VARIOUS REMEDIAL ACTIONS IS TO SELECT AN ENVIRONMENTALLY ACCEPTABLE AND TECHNICALLY/ECONOMICALLY FEASIBLE ALTERNATIVE FOR IMPLEMENTATION. THIS EVALUATION CONSIDERS VIABLE REMEDIAL TECHNOLOGIES TO ADDRESS SOIL AND GROUND WATER CONTAMINATION AT THE CWP SITE. THE EVALUATION HAS BEEN PERFORMED ACCORDING TO THE PROCEDURE OUTLINED BY THE EPA IN A DOCUMENT ENTITLED "GUIDANCE ON FEASIBILITY STUDIES UNDER CERCLA" (US EPA, JUNE 1985B).

SECTION 7.1 PRESENTS AN EVALUATION OF THE VARIOUS REMEDIAL TECHNOLOGIES CONSIDERED. THOSE SELECTED FOR IMPLEMENTATION, BASED ON TECHNICAL, ENVIRONMENTAL, AND COST CONSIDERATIONS, ARE DESCRIBED IN SECTION 7.2. THE RATIONALE FOR SELECTING THE RECOMMENDED ALTERNATIVE AND REJECTING THE OTHERS IS PRESENTED IN SECTION 7.3. THE ENVIRONMENTAL EFFECTS OF THE RECOMMENDED ALTERNATIVE AND THE APPLICABLE LAWS AND REGULATIONS ARE PRESENTED IN SECTIONS 7.4 AND 7.5.

AS DESCRIBED IN SECTION 5.0, A NUMBER OF INTERIM REMEDIAL MEASURES HAVE BEEN IMPLEMENTED IN THE COURSE OF THE REMEDIAL INVESTIGATIONS AT THE SITE. THEREFORE, IN THE EVALUATION OF REMEDIAL ACTION ALTERNATIVES, THE INTERIM REMEDIAL ACTIONS ALREADY IMPLEMENTED HAVE BEEN CONSIDERED.

7.1 ALTERNATIVE REMEDIAL ACTIONS

REMEDIAL ALTERNATIVES MAY BE CATEGORIZED AS PERTAINING TO SOURCE CONTROL OR MANAGEMENT OF MIGRATION (US EPA, JUNE 1985A). FOR THE CWP SITE, SOURCE CONTROL REFERS TO THE CONTROL OF CONTAMINATED SOIL TO REDUCE OR PREVENT INTRODUCTION OF THE CONTAMINANTS TO GROUND WATER. MANAGEMENT OF MIGRATION REFERS TO CONTAINMENT OF THE CHROMIUM PLUME AND REMEDIATION OF THE IMPACTED WATER-BEARING ZONE.

THE TECHNOLOGIES EVALUATED TO ADDRESS SOIL AND GROUND WATER CONTAMINATION RANGE FROM COMPLETE REMEDIATION TO NO ACTION. THE EVALUATION OF VIABLE OPTIONS TO ADDRESS CONTAMINATED SOIL IS PRESENTED IN SECTION 7.1.1. REMEDIATION OF CONTAMINATED SOILS WILL OCCUR AT THE TIME OF CLOSURE OF THE FACILITY. THE CLOSURE OF THE FACILITY IS PROJECTED TO OCCUR IN 10 YEARS. A TRUST FUND WILL BE ESTABLISHED (SECTION 9.0) TO FUND FUTURE REMEDIATION OF SOILS. TREATABILITY STUDIES WILL BE CONDUCTED PRIOR TO SELECTING THE FINAL SOILS REMEDY AT THE TIME OF CLOSURE OF THE FACILITY. THE EVALUATION OF THE TECHNOLOGIES AVAILABLE TO ADDRESS GROUND WATER CONTAMINATION IS PRESENTED IN SECTION 7.1.2. AS EXTRACTION IS A VIABLE OPTION FOR THE REMEDIATION OF GROUND WATER CONTAMINATION, ALTERNATIVE METHODS OF GROUND WATER TREATMENT HAVE ALSO BEEN EVALUATED. THIS EVALUATION IS PRESENTED IN SECTION 7.1.3. THE OPTIONS FOR THE DISCHARGE OF TREATED GROUND WATER ARE EVALUATED IN SECTION 7.1.4.

7.1.1 CONTROL OF CONTAMINATED SOIL

PREVIOUS INVESTIGATIONS HAVE DELINEATED THE AREAL EXTENT OF SOILS CONTAINING ELEVATED CONCENTRATIONS OF CHROMIUM AND ARSENIC. VERTICALLY, SOILS CONTAINING OVER 100 MG/KG OF CHROMIUM AND ARSENIC ABOVE BACKGROUND LEVEL (15 MG/KG) OCCUR PREDOMINANTLY WITHIN THE UPPER 1 FOOT OF THE SOIL PROFILE. MOST SOIL SAMPLES COLLECTED BELOW A DEPTH OF 1 FOOT CONTAIN LESS THAN 50 MG/KG OF TOTAL CHROMIUM AND ARSENIC CONCENTRATIONS IN THE RANGE OF BACKGROUND LEVELS. MORE SPECIFICALLY, OF THE 25 SOIL SAMPLES COLLECTED FROM THE 3-FOOT DEPTH, ONLY 5 CONTAINED MORE THAN 50 MG/KG OF TOTAL CHROMIUM AND NONE CONTAINED MORE THAN 100 MG/KG. THE FOUR 3-FOOT SAMPLES CONTAINING OVER 50 MG/KG WERE FROM BORINGS S-2, S-4, S-6, S-12, S-14, AND S-23, WHICH ARE SPATIALLY DISTRIBUTED ACROSS THE SITE AND DO NOT INDICATE A SINGLE SOURCE SUCH AS THE RETORTS ON TREATED WOOD STORAGE AREAS. IN PARTICULAR, IT IS NOTED THAT BORING S-23 IS LOCATED OFF SITE, ACROSS TAYLOR DRIVE. THE DISTRIBUTION OF ELEVATED TOTAL CHROMIUM CONCENTRATIONS, I.E. GREATER THAN MG/KG, AT DEPTHS OF 6 AND 10 FEET BELOW GRADE IS SIMILAR TO THAT DESCRIBED ABOVE AT THE 3-FOOT DEPTH. ACCORDINGLY, THE AREAL DISTRIBUTION OF TOTAL CHROMIUM IS BEST REPRESENTED BY ISOCONCENTRATIONS AT THE 1-FOOT DEPTH. THE APPROXIMATE DISTRIBUTION OF SOILS CONTAINING OVER 100 MG/KG OF CHROMIUM AT THE 1-FOOT DEPTH IS SHOWN IN FIGURE 11. THIS DELINEATION OF CHROMIUM DISTRIBUTION AND OTHER PERTINENT REMEDIAL INVESTIGATION FINDINGS (SECTION 4.0) HAVE BEEN USED AS A BASIS FOR DEVELOPING AND EVALUATING VARIOUS REMEDIAL TECHNOLOGIES. THE POTENTIAL REMEDIAL TECHNOLOGIE CONSIDERED FOR CONTROL OF THE CONTAMINATED SOIL INCLUDE:

- SOIL REMOVAL AND OFF-SITE DISPOSAL
- SOIL REMOVAL AND ON-SITE TREATMENT
- IN-SITU TREATMENT
- PARTIAL EXCAVATION
- CONTAINMENT
- NO ACTION.

7.1.1.1 SOIL REMOVAL AND OFF-SITE DISPOSAL

THIS TECHNOLOGY CONSIDERS REMOVAL AND OFF-SITE DISPOSAL OF SOIL IN WHICH THE CHROMIUM CONCENTRATION IS ABOVE 100 MG/KG AND THE ARSENIC CONCENTRATION IS ABOVE 15 MG/KG. THE CONCENTRATION FOR CHROMIUM HAS BEEN SELECTED ON THE BASIS OF THE PREVIOUS SOIL QUALITY CHARACTERIZATION WHICH DEMONSTRATED THAT 100 MG/L MAY BE CONSIDERED TO BE DEFINITELY ABOVE BACKGROUND LEVELS. BASED ON THE 100 MG/KG TOTAL CHROMIUM ISOCONCENTRATION SHOWN IN FIGURE 11, THE AREA OF CONCERN IS ESTIMATED TO BE ABOUT 69,800 FT2 OR 1.60 ACRES. TO ESTIMATE THE VOLUME OF CONTAMINATED SOIL, IT HAS BEEN ASSUMED THAT THE SOIL IS UNIFORMLY CONTAMINATED TO AN AVERAGE DEPTH OF 1.5 FEET BELOW GRADE. BASED ON THIS ASSUMPTION, THE VOLUME OF CONTAMINATED SOIL WOULD BE APPROXIMATELY 3,880 CUBIC YARDS. IT SHOULD BE NOTED THAT IN CERTAIN AREAS, SUCH AS THE MAIN PROCESS AREA, THE DEPTH OF CONTAMINATION MAY BE GREATER. ACCORDINGLY, IN THE ABSENCE OF ANY OTHER DATA, IT HAS BEEN ASSUMED THAT THE AREA BENEATH THE RETORTS AND THE RAIL LINES, MEASURING ABOUT 50 FEET BY 280 FEET, IS CONTAMINATED WITH MORE THAN 100 MG/KG TOTAL CHROMIUM AND MORE THAN 15 MG/KG ARSENIC TO AN AVERAGE DEPTH OF 5 FEET BELOW GRADE. THE ADDITIONAL VOLUME WITHIN THIS ARBITRARY ZONE IS 1,890 CUBIC YARDS. THE ESTIMATED TOTAL VOLUME OF SOIL CONTAINING 100 MG/KG OR MORE OF TOTAL CHROMIUM IS ESTIMATED TO BE 5,770 CUBIC YARDS.

TYPICALLY, SOIL EXCAVATION TO A DEPTH OF 1 TO 2 FEET WOULD BE PERFORMED BY DOZERS AND THE SOIL LOADED ONTO TRUCKS AND TRANSPORTED TO A LICENSED HAZARDOUS WASTE FACILITY APPROVED BY THE EPA AND IN ACCORDANCE WITH APPLICABLE SARA REQUIREMENTS. THE NEAREST OPERATING FACILITY TO THE SITE IS IN KETTLEMAN CITY, LOCATED IN CENTRAL CALIFORNIA.

COMPLETE REMOVAL OF CONTAMINATED SOIL, TO THE LIMITS SHOWN IN FIGURE 11, WOULD REQUIRE THE CESSATION OF WOOD PRESERVING OPERATIONS AND THE REMOVAL OF THE WOOD PRESERVING FACILITIES. THEREFORE, IT HAS BEEN ASSUMED THAT ANY SUCH REMEDIATION WOULD OCCUR SUBSEQUENT TO THE CLOSURE OF THE CWP OPERATION. THE ESTIMATED COST FOR REMOVAL AND OFF-SITE DISPOSAL OF 5,770 CUBIC YARDS OF SOIL IS PRESENTED IN TABLE 12.

7.1.1.2 SOIL REMOVAL AND ON-SITE TREATMENT

THIS ALTERNATIVE INCLUDES EXCAVATION AND REMOVAL OF SOIL, FOLLOWED BY ON-SITE TREATMENT. ON-SITE TREATMENT MAY INVOLVE THE USE OF ORGANIC OR INORGANIC POLYMERS WHICH HAVE THE CAPABILITY OF BINDING THE METALS, MAKING THEM LESS SUSCEPTIBLE TO LEACHING. THESE TECHNOLOGIES HAVE NOT BEEN TESTED AT FIELD SCALE; THUS, IT IS NOT KNOWN HOW APPLICABLE THEY MAY BE TO THE CWP SITE. TO REALISTICALLY EVALUATE ON-SITE TREATMENT AS A REMEDIAL OPTION FOR CONTAMINATED SOIL, LABORATORY AND FIELD TESTS ARE NEEDED. NORMALLY, A NUMBER OF PRODUCTS ARE TESTED TO ASSESS THEIR FIXATION POTENTIAL. THE FIXATION POTENTIAL IS DETERMINED BY EVALUATING THE LEACHING BEHAVIOR OF THE SOIL PRIOR TO AND AFTER TREATMENT. IF LABORATORY TESTS INDICATE THAT A PARTICULAR TREATMENT IS ACCEPTABLE IN TERMS OF LEACHING, A PILOT TEST IS GENERALLY PERFORMED TO ASSESS THE APPLICABILITY OF THE TECHNOLOGY TO FIELD CONDITIONS. IF THE PILOT TEST DEMONSTRATES THAT THE METHOD IS APPLICABLE TO FIELD-SCALE REMEDIATION, A DETAILED DESIGN IS PREPARED. GEOSYSTEM'S EXPERIENCE IN SIMILAR PROJECTS SHOWS THAT ON-SITE TREATMENT IS FEASIBLE.

FOR COST ESTIMATING PURPOSES, IT HAS BEEN ASSUMED THAT ON-SITE TREATMENT IS A FEASIBLE REMEDIAL OPTION. IT IS NOTED, HOWEVER, THAT DESPITE THE AVOIDANCE OF THE HIGH COST OF OFF-SITE DISPOSAL, THE ESTIMATED COST OF ON-SITE TREATMENT IS STILL RELATIVELY HIGH. THIS IS DUE PRIMARILY TO THE DURATION OF IMPLEMENTATION. THE ESTIMATED COSTS ASSOCIATED WITH EXCAVATION AND ON-SITE TREATMENT ARE SHOWN IN TABLE 12.

7.1.1.3 IN-SITU TREATMENT

THIS OPTION INCLUDES IN-SITU PHYSICAL AND/OR CHEMICAL TREATMENT TO FIX THE CHROMIUM AND ARSENIC IN SOIL TO THE EXTENT THAT IT WOULD NOT ACT AS A SOURCE TO GROUND WATER CONTAMINATION. THE SIMPLEST IN-SITU TREATMENT METHOD WOULD BE LEACHING THE SOIL WITH WATER AND EXTRACTING AND TREATING THE LEACHATE. IF THIS METHOD WERE CHOSEN, THE PAVEMENT WOULD HAVE TO BE REMOVED TO

ALLOW WATER TO PERCOLATE THROUGH THE CONTAMINATED SOIL AND LEACH THE CHROMIUM.

PREVIOUS LABORATORY LEACHABILITY STUDIES (IT/D'APPOLONIA, MAY 1984) HAVE SHOWN THAT UNDER ACIDIC CONDITIONS (PH = 5.0), A MAXIMUM OF 2.8 PERCENT CHROMIUM IS RECOVERABLE. THESE RESULTS HAVE ALSO INDICATED THAT MOST OF THE CHROMIUM IN THE SOIL IS IN THE CR(III) FORM. THE TRIVALENT FORMS OF CHROMIUM ARE MORE STABLE, LESS SOLUBLE, AND LESS MOBILE THAN THE HEXAVALENT FORMS. THEREFORE, IF IN-SITU LEACHING WAS PERFORMED WITH A NEUTRAL PH SOLUTION (WATER), LOWER CHROMIUM RECOVERY WOULD BE EXPECTED. CONSIDERING THE LEACHING CHARACTERISTICS OF TRIVALENT CHROMIUM AND OPERATIONAL CONSTRAINTS, IN-SITU LEACHING DOES NOT APPEAR TO BE AN EFFICIENT MEANS OF REMEDIATION.

OTHER OPTIONS INCLUDE INJECTION OF COMPOUNDS INTO THE SOIL TO CHEMICALLY FIX THE CHROMIUM AND ARSENIC IN SOIL. THIS OPTION IS GENERALLY MORE EFFECTIVE IN HOMOGENEOUS, SATURATED AQUIFER SYSTEMS OF HIGH PERMEABILITY. GIVEN THE COMPLEX STRATIGRAPHY AND DISCONTINUITY OF PERMEABLE STRATA AT THE SITE, THIS TYPE OF IN-SITU TREATMENT IS JUDGED TO BE INEFFECTIVE AND HAS NOT BEEN CONSIDERED FURTHER.

7.1.1.4 PARTIAL EXCAVATION AND OFF-SITE DISPOSAL

PARTIAL EXCAVATION IS ANOTHER VIABLE ALTERNATIVE TO CONTROL CONTAMINATED SOIL AT THE SITE. BASED ON PREVIOUS SITE INVESTIGATIONS, THE AREAS OF SOIL CONTAINING MORE THAN 130 MG/KG OF CHROMIUM AND 15 MG/KG OF ARSENIC HAVE BEEN IDENTIFIED IN FIGURE 11 OF THE D'APPOLONIA (1984) REPORT. THESE AREAS CENTER AROUND BORINGS S-4, S-5, AND S-8 AND SAMPLING LOCATIONS G-5, G-10, AND G-11. THE LOCATIONS OF THESE BORINGS AND SAMPLING LOCATIONS ARE SHOWN IN FIGURE 11. THE 130 MG/KG CR CONCENTRATION WAS CHOSEN BECAUSE IT ENABLED AREAS WITHIN THE 100 MG/KG SOIL CONTAMINATION BOUNDARY TO BE ADDRESSED WITHOUT COMPLETE SOIL REMOVAL. IT IS NOTED THAT THE AREAL EXTENT OF ARSENIC CONTAMINATION GENERALLY COINCIDES WITH THAT OF CHROMIUM (FIGURE 11). BASED ON A DEPTH OF CONTAMINATION OF 2 FEET, PARTIAL EXCAVATION WOULD RESULT IN AN ESTIMATED SOIL VOLUME OF ABOUT 3,300 CUBIC YARDS. THE ESTIMATED COSTS ASSOCIATED WITH IMPLEMENTATION OF THIS OPTION ARE SUMMARIZED IN TABLE 12.

7.1.1.5 CONTAINMENT

THE SIMPLEST METHOD OF CONTAINMENT IS TO PROVIDE SURFACE PAVING OVER THE AREAS KNOWN TO CONTAIN GREATER THAN 100 MG/KG OF CHROMIUM AND 15 MG/KG OF ARSENIC. THE SURFACE PAVING OR CAPPING WOULD PREVENT INFILTRATION OF SURFACE WATER THROUGH THE CONTAMINATED SOIL AND CONSEQUENTLY MINIMIZE OR ELIMINATE THE LEACHING OF CHROMIUM INTO GROUND WATER. SURFACE PAVING HAS BEEN INSTALLED AT THE SITE IN VARIOUS PHASES SINCE 1979. THE PRESENT EXTENT OF SURFACE PAVING IS SHOWN IN FIGURE 2. COMPARISON WITH THE AREA OF NEAR-SURFACE SOIL CONTAMINATION DEMONSTRATES THAT THE LARGE MAJORITY OF CHROMIUM-CONTAINING SOILS ARE LOCATED BENEATH THE PAVED AREA. MAINTENANCE OF THE INTEGRITY OF THE EXISTING CAP IS AN ESSENTIAL COMPONENT OF EFFECTIVE CONTAINMENT PRIOR TO IMPLEMENTATION OF A PERMANENT REMEDY. APPROXIMATELY 3 PERCENT OF THE CONTAMINATED SOIL AREA IS NOT CURRENTLY PAVED. RECOMMENDATIONS CONCERNING THESE REMAINING UNPAVED AREAS ARE PRESENTED IN SECTION 7.2.

OTHER METHODS OF CONTAINMENT INCLUDE PHYSICAL BARRIERS, SUCH AS SLURRY, SHEET PILE, OR CHEMICAL GROUT CUTOFF WALLS; OR HYDRAULIC BARRIERS, SUCH AS EXTRACTION/INJECTION SYSTEMS. THESE OPTIONS ARE ADDRESSED FURTHER IN RELATION TO PLUME CONTROL IN SECTION 7.1.2.

7.1.1.6 NO ACTION

THIS OPTION ALLOWS THE CONTAMINATED SOIL TO REMAIN IN PLACE, UNREMEDIATED. IMPLEMENTATION OF THE NO ACTION OPTION IS TYPICALLY COMBINED WITH OTHER CONTROL MEASURES IF GROUND WATER CONTAMINATION IS OF CONCERN. ALSO, THE NO ACTION OPTION REQUIRES EXTENSIVE MONITORING TO EVALUATE THE POTENTIAL IMPACT OF RESIDUAL SOIL CONTAMINATION ON THE ENVIRONMENT. GROUND WATER MONITORING DATA, GENERATED SINCE 1981, HAVE INDICATED SOME IMPROVEMENT IN WATER QUALITY, PRIMARILY IN OFF-SITE AREAS. APPLICATION OF THE NO ACTION ALTERNATIVE TO THE ENTIRE SITE WOULD, HOWEVER, REQUIRE FURTHER EVALUATION OF THE POTENTIAL IMPACT ON GROUND WATER QUALITY AND THE ENVIRONMENT, AS DESCRIBED IN SECTION 7.3.

7.1.2 PLUME CONTROL

PLUME CONTROL MEASURES WOULD BE DESIGNED TO LIMIT THE MIGRATION OF THE DISSOLVED CONSTITUENTS WHILE GRADUALLY REMEDIATING EXISTING CONTAMINATION. THE ALTERNATIVES CONSIDERED FOR SCREENING

ARE AS FOLLOWS:

- PHYSICAL CONTAINMENT
- IN-SITU TREATMENT
- HYDRAULIC CONTROL
- ELECTROKINETIC TREATMENT
- NO ACTION.

7.1.2.1 PHYSICAL CONTAINMENT

PHYSICAL CONTAINMENT MEASURES INCLUDE SLURRY CUTOFF WALLS, SHEET PILES, AND GROUT CURTAINS. THE MOST COMMON METHOD OF PHYSICAL CONTAINMENT FOR PLUME CONTROL IS THE CONSTRUCTION OF SLURRY CUTOFF WALLS. THIS OPTION, PER SE, DOES NOT REMEDIATE THE AQUIFER; HOWEVER, THE CONTAMINANTS ARE CONTAINED. A SLURRY CUTOFF WALL IS CONSTRUCTED BY EXCAVATING A CONTINUOUS, NARROW TRENCH WHICH IS KEPT FILLED WITH BENTONITE SLURRY TO STABILIZE THE SIDES OF THE EXCAVATION. THE TRENCH IS BACKFILLED WITH A MIXTURE OF EXCAVATED SOIL AND BENTONITE AS TRENCHING PROGRESSES. BACKFILLING DISPLACES THE SLURRY, WHICH IS RECYCLED. THE SLURRY WALL ACTS AS A BARRIER TO LATERAL GROUND WATER FLOW IF THE ZONE OF CONTAMINATION IS COMPLETELY CONTAINED. OTHERWISE, HYDRAULIC CONTROL MUST BE INITIATED TO PROVIDE ADEQUATE CONTAINMENT. FLOW BENEATH THE WALL IS RESTRICTED BY EITHER KEYING THE WALL INTO A LOW PERMEABILITY STRATUM OR BY HYDRAULIC CONTROL. AS DISCUSSED IN SECTION 5.2, THIS OPTION HAS BEEN IMPLEMENTED AS AN INTERIM REMEDIAL MEASURE BY CWP. OTHER PHYSICAL CONTAINMENT MEASURES, SUCH AS SHEET PILES AND GROUT CURTAINS, HAVE NOT, THEREFORE, BEEN CONSIDERED FURTHER.

7.1.2.2 IN-SITU TREATMENT

THIS TECHNOLOGY INVOLVES THE PASSAGE OF A TREATMENT AGENT THROUGH THE CONTAMINATED AQUIFER, USUALLY BY PUMPING AND/OR INJECTION.

THE EFFECTIVENESS OF THIS OPTION DEPENDS PRIMARILY ON THE PERMEABILITY OF THE CONTAMINATED MEDIUM, THE CONTINUITY OF THE WATER-BEARING ZONE, AND THE DEGREE OF BONDING OF CHROMIUM TO SOIL PARTICLES. IN-SITU TREATMENT BY THIS METHOD IS NOT A PROVEN TECHNOLOGY, PARTICULARLY IF CONSIDERED FOR APPLICATION TO CHROMIUM FIXATION IN LARGE AREAS. RESEARCH RELATED TO APPLICATION OF THIS TECHNOLOGY IS UNDERWAY, AND IF FUTURE DATA SHOW PROMISING RESULTS, ITS APPLICATION TO THE CWP SITE COULD BE RECONSIDERED. AT THIS TIME, HOWEVER, IN-SITU TREATMENT BY CHEMICAL FIXATION HAS NOT BEEN CONSIDERED FURTHER.

7.1.2.3 HYDRAULIC CONTROL

HYDRAULIC CONTROL IS AN ACCEPTED AND WELL DOCUMENTED METHOD OF PLUME CONTROL AND AQUIFER REMEDIATION. THIS OPTION INCLUDES EXTRACTION AND/OR INJECTION IN ORDER TO PRODUCE A ZONE OF INFLUENCE BEYOND WHICH THERE WILL NOT BE SIGNIFICANT MIGRATION OF CONTAMINANTS. EXTRACTED GROUND WATER IS REPLENISHED BY CONTAMINANT-FREE GROUND WATER, RESULTING IN A GRADUAL REDUCTION IN CHROMIUM CONCENTRATIONS.

CONSIDERING THE CHROMIUM ISOCONCENTRATIONS SHOWN IN FIGURES 12, 13, AND 14, THE APPLICATION OF HYDRAULIC CONTROL IS BELIEVED TO BE RELEVANT TO THE FOLLOWING GEOGRAPHIC AREAS:

- NEAR THE RETORTS
- NEAR THE EASTERN SITE BOUNDARY
- OFF SITE TO THE SOUTHEAST.

THE GROUND WATER QUALITY DATA HAVE SHOWN THAT CHROMIUM CONCENTRATIONS ARE HIGHER IN ZONE 1 IN THE RETORT AREA THAN IN OTHER LOCATIONS. TO PREVENT CHROMIUM MIGRATION FROM THE RETORT AREA TO DOWNGRADIENT LOCATIONS, INTERCEPTION OF THE PLUME BY TRENCHES OR LARGE DIAMETER RECOVERY WELLS HAS BEEN CONSIDERED. BOTH OF THESE METHODS COULD PROVIDE A BARRIER TO CHROMIUM MIGRATION WITHIN THEIR RESPECTIVE RADII OF INFLUENCE. TRENCHES ARE TYPICALLY MORE EFFECTIVE WATER-BEARING ZONES WHICH ARE NOT VERY CONDUCTIVE AND LACK HYDRAULIC CONTINUITY; HOWEVER, THE PRESENCE OF WOOD PRESERVING FACILITIES IN THE RETORT AREA PRECLUDES THE INSTALLATION OF A TRENCH. AS DESCRIBED IN SECTION 5.3, A LARGE-DIAMETER RECOVERY WELL, WELL CWP-18, WAS INSTALLED NEAR THE RETORT AREA AS AN INTERIM REMEDIAL MEASURE.

PLUME CONTROL NEAR THE EASTERN SITE BOUNDARY HAS ALSO BEEN CONSIDERED IN ORDER TO PREVENT

OFF-SITE MIGRATION. AS DESCRIBED IN SECTION 5.2, THIS OPTION INCLUDES EXTRACTION FROM WELL HL-7 AND HAS BEEN IMPLEMENTED AS AN INTERIM REMEDIAL MEASURE. IN ADDITION TO EXTRACTION FROM WELL HL-7, PUMPING FROM THE DOWNGRADIENT SIDE OF THE SLURRY WALL WOULD CONTAIN ANY CONTAMINATION WHICH MAY HAVE PASSED THE BARRIER AND ACTS AS A SOURCE OF OFF-SITE CONTAMINATION:

OFF-SITE REMEDIATION HAS BEEN CONSIDERED BECAUSE OF THE PRESENCE OF CHROMIUM IN SOME OFF-SITE WELLS IN THE PAST. OFF-SITE REMEDIATION HAS BEEN EVALUATED IN SOME DETAIL (GEOSYSTEM, APRIL 1987) AND IS NOT BELIEVED TO BE NECESSARY AT THIS TIME. THIS JUDGEMENT IS BASED ON CURRENT GROUND WATER QUALITY AND THE TREND OF IMPROVING WATER QUALITY IN OFF-SITE AREAS AS A RESULT OF THE INTERIM REMEDIAL MEASURES IMPLEMENTED NEAR THE EASTERN SITE BOUNDARY. IT SHOULD BE NOTED, HOWEVER, THAT FUTURE MONITORING AND NEW REGULATIONS MAY DICTATE RECONSIDERATION OF OFF-SITE REMEDIATION.

HYDRAULIC CONTROL MEASURES WHICH INVOLVE THE EXTRACTION OF CONTAMINATED GROUND WATER REQUIRE AN ENVIRONMENTALLY-ACCEPTABLE AND COST-EFFECTIVE METHOD OF HANDLING THE EXTRACTED WATER. AS PREVIOUSLY MENTIONED, THE MAJORITY OF THE EXTRACTED CHROMIUM CONTAINING WATER IS RECYCLED BACK INTO CWP'S WOOD PRESERVING OPERATIONS; THEREFORE, NO SPECIAL HANDLING IS REQUIRED. EXCESS CONTAMINATED WATER MUST, HOWEVER, BE TREATED PRIOR TO DISCHARGE. SECTION 7.1.3 SUMMARIZES THE ALTERNATIVE TREATMENT PROCESSES CONSIDERED TO ACHIEVE ACCEPTABLE EFFLUENT QUALITY.

7.1.2.4 ELECTROKINETIC PHENOMENA

ELECTROKINETIC PHENOMENA REFERS TO THOSE METHODS BY WHICH MIGRATION OF DISSOLVED CONTAMINANTS IN GROUND WATER IS ENHANCED BY THE APPLICATION OF AN ELECTRIC CURRENT. THE METHODOLOGY IS BASED ON INDUCING ELECTRICAL GRADIENTS TO THE SOIL-ELECTROLYTE-WATER SYSTEM, RESULTING IN DISPLACEMENT OR MIGRATION OF CATIONS AND ANIONS. HISTORICALLY, THIS TECHNOLOGY HAS ACHIEVED SOME DEGREE OF SUCCESS IN INDUCING FLOW IN LOW PERMEABILITY DISPERSIVE SOILS. APPLICATION OF THIS METHOD TO THE REMOVAL OF INORGANIC SPECIES AND DEWATERING HAS BEEN DEMONSTRATED BY A NUMBER OF INVESTIGATIONS (MITCHELL AND ARULANANDAN, 1968; GRAY AND MITCHELL, 1967; MEHRAN, 1971). RECENTLY, THE EPA HAS INITIATED A NUMBER OF PROJECTS TO TEST THE APPLICABILITY OF THIS TECHNOLOGY TO FIELD-SCALE PROBLEMS. AS THIS TECHNOLOGY IS STILL IN THE DEVELOPMENTAL STAGE, HOWEVER, IT HAS NOT BEEN CONSIDERED FURTHER FOR IMPLEMENTATION AT THE CWP SITE.

7.1.2.5 NO ACTION

THIS OPTION ALLOWS THE DISSOLVED CONTAMINANTS TO MIGRATE UNCONTROLLED AND UNREMEDIATED. THIS OPTION WOULD RESULT IN AN EXPANSION OF THE PLUME IN THE DOWNGRADIENT DIRECTION AND WOULD PLACE POTENTIAL BIOLOGICAL RECEPTORS AT RISK.

7.1.3 GROUND WATER TREATMENT TECHNOLOGY ASSESSMENT

AS MENTIONED IN SECTION 5.0, CWP IS ABLE TO UTILIZE EXTRACTED GROUND WATER IN WOOD PRESERVING OPERATIONS AT CERTAIN TIMES OF THE YEAR. WHEN THE SUPPLY OF EXTRACTED GROUND WATER EXCEEDS CWP'S NEEDS, HOWEVER, TREATMENT IS REQUIRED BEFORE DISCHARGE.

THE EVALUATION OF THE VARIOUS GROUND WATER TREATMENT TECHNOLOGIES IS BASED ON A CONTINUOUS EXTRACTION RATE OF 5 TO 20 GPM FOR SEVEN YEARS, A CHROMIUM CONCENTRATION OF LESS THAN 10 MG/L IN THE INFLUENT, AND A REQUIRED EFFLUENT CONCENTRATION OF LESS THAN 0.05 MG/L.

THE TREATMENT TECHNOLOGIES HAVE BEEN SCREENED ON THE BASIS OF THE FOLLOWING TECHNICAL AND ECONOMIC CRITERIA:

- PERFORMANCE AND EFFECTIVENESS OF THE TECHNOLOGY.
- PROJECTED SERVICE LIFE.
- DEMONSTRATED RELIABILITY.
- EASE OF IMPLEMENTATION.
- SAFETY CONSIDERATIONS.
- CAPITAL COSTS.
- OPERATION AND MAINTENANCE COSTS.

THE OPERATION AND MAINTENANCE (O & M) COSTS ARE THOSE POSTCONSTRUCTION COSTS NECESSARY TO MAINTAIN SATISFACTORY OPERATION OF THE TREATMENT SYSTEM AND THE REQUIRED MONITORING (TABLE 13).

THE OBJECTIVE OF THE SCREENING WAS TO ELIMINATE THOSE TECHNOLOGIES THAT HAVE AN ORDER OF MAGNITUDE GREATER COST, BUT DO NOT PROVIDE GREATER ENVIRONMENTAL OR PUBLIC HEALTH BENEFITS OR GREATER RELIABILITY. THE TECHNOLOGIES CONSIDERED FOR SCREENING WERE:

- ELECTROCHEMICAL PROCESS.
- CHEMICAL REDUCTION AND PRECIPITATION.
- CHEMICAL PRECIPITATION WITH SEDIMENTATION OR FILTRATION.
- ACTIVATED CARBON ADSORPTION.
- ION EXCHANGE.
- ELECTRODIALYSIS.

7.1.3.1 ELECTROCHEMICAL PROCESS

THE ELECTROCHEMICAL PROCESS INVOLVES PASSING CHROMIUM-CONTAINING GROUND WATER THROUGH A CELL CONTAINING CONSUMABLE IRON ELECTRODES WHICH, IN THE PRESENCE OF AN ELECTRICAL CURRENT, GENERATE FERROUS AND HYDROXIDE IONS. THESE IONS REACT WITH CHROMATE IONS IN SOLUTION TO PRECIPITATE CHROMIC AND FERRIC HYDROXIDES. THIS PROCESS IS UNIQUE IN THAT NO CHEMICAL ADDITIVES ARE REQUIRED TO GENERATE THE PRECIPITANT. THE ELECTROCHEMICAL OPERATION IS A "ONCE-THROUGH PROCESS" REQUIRING MINIMAL REACTION TIME. THE THEORY OF OPERATION INVOLVES AN OXIDATION-REDUCTION REACTION WHEREBY ELECTRONS ARE SUPPLIED BY AN EXTERNAL ELECTRICAL SOURCE REDUCING THE METAL IONS IN THE ELECTROLYTE TO FORM ELEMENTAL METAL AT THE CATHODE SURFACE. THE EQUIPMENT CONSISTS OF A REACTOR MODULE CONTAINING THE ANODE AND CATHODE ASSEMBLIES AND TWO CONTROLLABLE POWER SUPPLIES. THE DETAILS OF THIS TECHNOLOGY RELATED TO ELECTRODE POTENTIALS, EQUILIBRIUM, OXIDATION-REDUCTION, AND MIXED POTENTIALS, VOLTAMMETRY, AND ELECTROCAPILLARITY CAPACITY HAVE BEEN DESCRIBED IN THE LITERATURE (AHMED, 1979; PEMSLER AND RAPPAS, 1979; AYRES AND FEDKIW, 1983; AND DEAN, ET AL., 1972). MORE SPECIFIC INFORMATION ON OPERATION OF ELECTROCHEMICAL PROCESS UNITS IS PRESENTED IN SECTION 7.2.4.

ELECTROCHEMICAL TREATMENT HAS BEEN USED FOR MANY YEARS IN THE MINING AND UTILITY INDUSTRIES AND IS A PROVEN TECHNOLOGY FOR REMOVING HEXAVALENT CHROMIUM FROM WASTEWATER. THE ELECTROCHEMICAL TREATMENT PROCESS, THEREFORE, IS CAPABLE OF REMOVING HEXAVALENT CHROMIUM FROM GROUND WATER EXTRACTED AT THE CWP SITE. THE SALIENT FEATURES OR THE ELECTROCHEMICAL PROCESS PERTINENT TO THE CWP SITE ARE SUMMARIZED IN TABLE 13. REMOVAL EFFICIENCY OF THE ELECTROCHEMICAL PROCESS FOR CHROMIUM IS DEMONSTRATED IN TABLE 14.

THE ADVANTAGES OF THE ELECTROCHEMICAL PROCESS ARE AS FOLLOWS:

- REDUCES THE CR(VI) CONTENT OF GROUND WATER TO EPA COMPATIBLE LEVELS.
- VERY LOW OPERATING COSTS.
- NO CONSUMABLE REAGENTS REQUIRED FOR OPERATION.
- REQUIRES LITTLE FLOOR SPACE AND OPERATOR ATTENTION.
- ELIMINATES THE CONVENTIONAL CHEMICAL PRECIPITATION PROCESS.

THE OPERATING COSTS FOR ELECTRODE CONSUMPTION, POWER, AND ACID FOR THE ELECTROCHEMICAL UNIT ARE ESTIMATED AT ABOUT 10 CENTS PER 1,000 GALLONS OF GROUND WATER TREATED. AT THE ANTICIPATED FLOW RATE OF 20 GPM, THE OPERATING COSTS AMOUNT TO ABOUT $1,000 ANNUALLY. LABOR AND WASTE DISPOSAL COSTS FOR THE ELECTROCHEMICAL PROCESS ARE ESTIMATED TO BE ABOUT $50 PER DAY.

7.1.3.2 CHEMICAL REDUCTION AND PRECIPITATION

THE MOST CONVENTIONAL METHOD FOR THE REMOVAL OF CHROMIUM IS REDUCTION OF THE HEXAVALENT CHROMIUM TO THE TRIVALENT STATE, FOLLOWED BY PH ADJUSTMENT TO FORM INSOLUBLE CARBONATES OR HYDROXIDES WHICH CAN BE REMOVED AS SLUDGES. SOME COMMON REDUCING AGENTS INCLUDE GASEOUS SULFUR DIOXIDE, SODIUM BISULFITE OR METABISULFITE, AND FERROUS SULFATE. IN THE REDUCTION OF HEXAVALENT CHROMIUM TO TRIVALENT CHROMIUM USING SULFUR DIOXIDE, THE OXIDATION STATE OF CHROMIUM CHANGES FROM +6 TO +3 (CR IS REDUCED) AND THE OXIDIZATION STATE OF SULFUR INCREASES FROM +2 TO +3 (S IS OXIDIZED).

$$2H_2CRO_4 + 3SO_2 + 3H_2O \text{ ---} \\ CR_2(SO_4)_3 + 5H_2O$$

SULFUR DIOXIDE IS SUPPLIED AS A GAS AND FED INTO THE CHROME REDUCTION TANK AS LIQUID THROUGH A VACUUM EDUCTOR-TYPE OF SULFONATOR. THE SULFONATOR IS CONTROLLED BY AN OXIDATION REDUCTION POTENTIAL (ORP) PROBE MEASURING FREE SULFIDES IN THE CHROME REDUCTION TANK. MIXING IS USUALLY

REQUIRED TO IMPROVE CONTACT BETWEEN THE REDUCTION AGENT AND THE GROUND WATER. REACTION TIMES VARY WITH REDUCING AGENTS, TEMPERATURE, PH, AND CONCENTRATION; HOWEVER, REDUCTION TIMES ARE ON THE ORDER OF MINUTES.

REDUCTION OF HEXAVALENT CHROMIUM REQUIRES PH ADJUSTMENT, NORMALLY WITH SULFURIC ACID, TO A PH OF APPROXIMATELY 2 TO 3. WHEN SULFUR DIOXIDE IS USED AS THE REDUCING AGENT, SULFONATORS MUST BE USED TO COMBINE SULFUR DIOXIDE WITH WATER TO FORM SULFUROUS ACID. THE SULFUROUS ACID REACTS WITH CHROMIUM TO FORM CHROMIC SULFATE. OTHER REDUCING AGENTS ARE ADDED AS SOLIDS OR AS SOLUTIONS. THE CHEMICAL REDUCTION IS FOLLOWED BY ALKALINE ADDITION, WHICH RESULTS IN PRECIPITATION OF CHROMIUM HYDROXIDE.

CHEMICAL REDUCTION FOLLOWED BY PRECIPITATION REQUIRES SEVERAL PROCESS STEPS, CONSUMES CHEMICAL ADDITIVES FOR PH ADJUSTMENT AND THE REDUCTION REACTION, AND GENERATES A SLUDGE THAT MUST BE DISPOSED OF AN AUTOMATED SYSTEM COULD BE PROVIDED TO CARRY OUT THESE OPERATIONS; HOWEVER, SOME OPERATOR ATTENTION WOULD BE REQUIRED. CHEMICAL REDUCTION CAN BE CARRIED OUT USING SIMPLE, READILY AVAILABLE EQUIPMENT AND REAGENTS.

CHEMICAL REDUCTION IS USED PRIMARILY FOR THE REDUCTION OF HEXAVALENT CHROMIUM, MERCURY, AND LEAD AND IS A WELL TESTED AND DOCUMENTED METHOD OF TREATMENT FOR THESE METALS. DUE TO ITS DOCUMENTED APPLICABILITY, LABORATORY AND PILOT-SCALE TESTS MAY NOT BE REQUIRED TO DETERMINE APPROPRIATE CHEMICAL FEED RATES AND REACTOR RETENTION TIME FOR THE REDUCTION OF HEXAVALENT CHROMIUM TO TRIVALENT CHROMIUM AT THE CWP SITE.

THE TOTAL CAPITAL COSTS FOR CHEMICAL REDUCTION, INCLUDING THE COSTS FOR CHEMICAL STORAGE, FEEDING, AND MIXING, WERE ESTIMATED TO BE $224,000 WITH A TOTAL ANNUAL O&M COST OF 5192,300 (US EPA, 1978) THESE COST ESTIMATES ARE BASED ON A 20 GPM SYSTEM USING THE 1987 ENR CONSTRUCTION COST INDEX.

7.1.3.3 CHEMICAL PRECIPITATION WITH SEDIMENTATION OR FILTRATION

THIS TECHNOLOGY INVOLVES THE ADDITION OF CHEMICALS TO AN AQUEOUS SOLUTION TO COMBINE DISPERSED PARTICLES INTO LARGER AGGLOMERATES WHICH ARE REMOVED DURING THE PRECIPITATION (SETTLING) PROCESS. PRECIPITATION IS A PHYSICOCHEMICAL PROCESS WHEREBY SOME OR ALL OF A SUBSTANCE IN SOLUTION IS TRANSFORMED INTO A SOLID PHASE. GENERALLY, LIME OR SODIUM SULFIDE IS ADDED TO THE GROUND WATER IN A RAPID MIXING TANK. THE WATER FLOWS TO A FLOCCULATION CHAMBER IN WHICH ADEQUATE MIXING AND RETENTION TIME IS PROVIDED FOR AGGLOMERATION OF PRECIPITATION PARTICLES BY ADDING AN AGENT SUCH AS ALUM. AGGLOMERATED PARTICLES ARE SEPARATED FROM THE LIQUID PHASE BY SETTLING IN A SEDIMENTATION CHAMBER AND/OR BY OTHER PHYSICAL PROCESSES SUCH AS FILTRATION.

PRECIPITATION IS APPLICABLE TO THE REMOVAL OF MOST METALS FROM WASTEWATER INCLUDING ZINC, CADMIUM, CHROMIUM, COPPER, FLUORIDE, LEAD, MANGANESE, AND MERCURY. CYANIDE AND OTHER IONS IN THE WASTEWATER MAY ALSO COMPLEX WITH METALS, MAKING TREATMENT BY PRECIPITATION LESS EFFICIENT. PRECIPITATION IS NON-SELECTIVE IN THAT COMPOUNDS OTHER THAN THOSE TARGETED MAY BE REMOVED. BOTH PRECIPITATION AND FLOCCULATION ARE NONDESTRUCTIVE AND GENERATE A LARGE VOLUME OF SLUDGE WHICH MUST BE DISPOSED. THE TECHNOLOGY IS, HOWEVER, CONSIDERED TO BE POTENTIALLY APPLICABLE TO THE TREATMENT OF CHROMIUM-CONTAINING GROUND WATER AT THE SITE.

PRECIPITATION AND FLOCCULATION POSE MINIMAL HEALTH AND SAFETY HAZARDS TO FIELD WORKERS. THE ENTIRE SYSTEM IS OPERATED AT NEAR AMBIENT CONDITIONS, ELIMINATING THE DANGER OF HIGH PRESSURE/HIGH TEMPERATURE OPERATION. WHILE THE CHEMICALS EMPLOYED ARE OFTEN SKIN IRRITANTS, THEY CAN BE HANDLED IN A SAFE MANNER.

ARUMU GAM (1976) STUDIED HYDROXIDE PRECIPITATION FOR THE RECOVERY OF CHROMIUM FROM SPENT TAN LIQUOR. THIS PRECIPITATION PROCESS WAS THE LEAST EXPENSIVE METHOD FOR THE REMOVAL AND RECOVERY OF CHROMIUM. USING LIME AND AT AN OPTIMUM PH OF 6.6, THE REMOVAL OF CHROMIUM EXCEEDED 98 PERCENT. THE PRECIPITATED CHROMIUM HYDROXIDE IS SEPARATED BY SETTLING, FILTERED, AND REDISSOLVED IN SULFURIC ACID TO FORM CHROMIUM SULFATE WHICH CAN BE RECYCLED FOR FURTHER TANNING. THE USE OF LIME WAS MORE ECONOMICAL THAN THE USE OF OTHER ALKALINES (NAOH, NA2CO3, AND NH4OH). THE USE OF LIME SOFTENING AND COAGULATION, USING ALUM FOR REMOVAL OF SUCH HEAVY METALS AS CR(III) AND CR(VI), HAS BEEN INVESTIGATED BY THE EPA (US EPA, 1978).

FOR A 20 GPM CHROMIUM REMOVAL SYSTEM, THE EQUIPMENT COST IS ESTIMATED TO BE $50,000 (EPA/625/6-85/006, UPDATED TO 1987 USING THE ENR CONSTRUCTION COST INDEX). A TOTAL CHEMICAL

COST OF $4.80 PER 1,000 GALLONS IS ESTIMATED FOR THIS PRECIPITATION PROCESS TO ACHIEVE AN EFFLUENT CONTAINING LESS THAN 0.05 MG/L OF CHROMIUM. THE ANNUAL O&M COST IS ESTIMATED TO BE $64,000 WITH A TOTAL CAPITAL COST OF $192,000.

7.1.3.4 ACTIVATED CARBON ADSORPTION

CHROMATES CAN BE EFFECTIVELY REMOVED FROM GROUND WATER BY PASSING THE CHROMATE-CONTAINING GROUND WATER THROUGH A COLUMN PACKED WITH ACTIVATED CARBON (YOSHIDA, ET AL., 1977). HUANG AND WU (1975) FOUND THAT THE REMOVAL OF CR(VI) BY CALCINATED CHARCOAL WAS MOST SIGNIFICANT AT LOW PH AND FOR LOW INITIAL CR(VI) CONCENTRATIONS. LANDRIGAN AND HALLOWELL (1975) DEMONSTRATED THAT ACTIVATED CARBON COULD BE USED BY SMALL PLATING FACILITIES FOR REMOVAL OF CHROMIUM. HUANG AND WU (1975) STUDIED THE EFFECT OF PH ON CR(III) AND CR(VI)

ADSORPTION BY FILTRASORB 400 ACTIVATED CARBON. CR(VI) WAS AT LEAST TWICE AS ADSORBABLE AS CR(III). THE OPTIMUM PH FOR ADSORPTIVE REMOVAL WAS 5.5 TO 6.0 FOR CR(VI) AND 5.0 FOR CR(III).

GRANULAR ACTIVATED CARBON (GAC) IS USUALLY PREFERRED SINCE IT CAN BE CHEMICALLY REGENERATED AND REUSED. POWDERED ACTIVATED CARBON (PAC) IS LESS EXPENSIVE, BUT IT CAN ONLY BE USED ON A ONCE-THROUGH BASIS.

ACTIVATED CARBON WILL ADSORB HEXAVALENT CHROMIUM AND MANY METALS COMPLEXED IN ORGANIC FORM. THE ADSORPTIVE CAPACITY DEPENDS ON THE CARBON PORE SIZE, SOLUTION PH, AND THE INITIAL AND FINAL CONCENTRATIONS OF THE METAL(S). ACTIVATED CARBON ADSORPTION IS CONSIDERED TO BE AN APPLICABLE TECHNOLOGY FOR THE REMOVAL OF CR(VI) FROM GROUND WATER AT THE CWP SITE. IN PARTICULAR, ACTIVATED CARBON ADSORPTION SHOWS CONSIDERABLE PROMISE FOR REMOVING LOW CONCENTRATIONS OF CHROMIUM (IN THE RANGE OF 1 TO 2 ,MG/L) REMAINING AFTER OTHER TREATMENT METHODS SUCH AS PRECIPITATION, CEMENTATION, ETC. REGENERATION OF THE SPENT CARBON IS POSSIBLE WITH THE USE OF CAUSTIC SOLUTION.

THERE ARE A NUMBER OF OPERATIONAL CONSIDERATIONS, HOWEVER, THAT MAKE CARBON ADSORPTION AN INAPPROPRIATE CHOICE AS A TREATMENT OPTION FOR GROUND WATER CONTAINING CR(VI), AS DISCUSSED BELOW:

- ON THE CARBON SURFACE, CR(VI) IS PARTIALLY REDUCED TO CR(III) WHICH DOES NOT ADSORB WELL ON CARBON.

- THE MAXIMUM ADSORPTION OF CR(VI) OCCURS AT A PH OF APPROXIMATELY 2.5. AT LOWER PH VALUES, THE CR(VI) IS REDUCED TO CR(III); AT HIGHER PH VALUES, THE ADSORPTION OF CR(VI) DECREASES RAPIDLY.

- CR(VI) CAN BE STRIPPED FROM THE CARBON WITH A CAUSTIC SOLUTION. REMOVAL OF CR(VI) CAN THEN BE ACCOMPLISHED BY CHEMICAL ADDITION AND PH ADJUSTMENT IN A MIXING VESSEL; HOWEVER, A CHROMIUM-CONTAMINATED SLUDGE IS GENERATED.

A CARBON ADSORPTION SYSTEM WITH CAUSTIC REGENERATION COULD BE DESIGNED TO REMOVE CR(VI) FROM GROUND WATER AT THE SITE, BUT CR(III) WOULD NOT BE REMOVED BY THIS METHOD. ALTHOUGH IT IS TRUE THAT HIGHER CONCENTRATIONS OF CR(III) IN THE EFFLUENT CAN BE TOLERATED, FOR CERTAIN METHODS OF TREATED WATER DISCHARGE, LOWER CONCENTRATIONS OF CR(III) ARE ADVANTAGEOUS. CERTAIN EQUIPMENT AND CHEMICALS ARE NEEDED TO CARRY OUT PH ADJUSTMENT OF THE GROUND WATER AND IN THE ADSORPTION OPERATION.

TYPICAL CAPITAL AND O&M COSTS ARE PRESENTED IN TABLE 13. ADDITIONAL EQUIPMENT, CONTROLS, AND CHEMICALS WOULD BE REQUIRED FOR CARBON REGENERATION, WHICH IS PREFERRED OVER A NONREGENERATION APPROACH, TO MINIMIZE THE COST OF CARBON REPLACEMENT CONTAMINATED CARBON DISPOSAL. HOWEVER, EVEN WITH THE USE OF CARBON REGENERATION, DISPOSAL OF CHROMIUM CONTAMINATED SLUDGE AND SOME SPENT CARBON WOULD BE NECESSARY. FOR THE REASONS STATED ABOVE, CARBON ADSORPTION WOULD NOT BE A COST-EFFECTIVE OPTION FOR THE REMOVAL OF CHROMIUM FROM GROUND WATER AT THE SITE.

7.1.3.5 ION EXCHANGE

THE ION EXCHANGE PROCESS FOR CHROMIUM REMOVAL IS SIMILAR IN OPERATION TO THE CARBON ADSORPTION SYSTEM DISCUSSED IN SECTION 7.1.3.4, WASTEWATER IS PASSED THROUGH A BED OF ION EXCHANGE RESIN, WHICH CONTAINS ACTIVE IONIC FUNCTIONAL GROUPS. CHROMIUM IONS ARE EXCHANGED AND REMOVED FROM THE

RESIN AND THEN SEPARATED BY PH ADJUSTMENT AND PRECIPITATION. ION EXCHANGE IS A PROCESS WHEREBY THE MOBILE IONS ARE REMOVED FROM THE GROUND WATER PHASE BY BEING EXCHANGED WITH RELATIVELY IMMOBILE IONS HELD BY THE ION EXCHANGE MATRIX (WEBER, 1972). THE REMOVAL OF CHROMIUM DEPENDS PRIMARILY ON THE VALENCE OF THE CHROMIUM ION, THE TYPE OF RESIN, AND THE CHROMIUM CONCENTRATION IN GROUND WATER. THE CHROMATE-DICHROMATE PAIR OF DIVALENT ANIONS PRESENTS A DIFFERENT CASE. IN ALKALINE SOLUTIONS, HEXAVALENT CHROMIUM EXISTS IN SOLUTION AS THE CHROMATE ION CRO4. AS PH DROPS BELOW 6, CHROMATE IONS CONDENSE TO FORM DICHROMATE IONS CR2O72 BOTH IONS APPEAR TO BE HELD SELECTIVELY OVER COMMON MONOVALENT ANIONS.

(R4N)2, CR2O72 + 2NAOH ----
(R4N)2, (CRO)4 + NA2CRO4+H2O

THIS REVERSIBILITY IS USED IN REMOVING HEXAVALENT CHROMIUM FROM GROUND WATER.

GROUND WATER ENTERS THE TOP OF THE RESIN COLUMN UNDER PRESSURE, PASSES DOWNWARD THROUGH THE RESIN BED, AND IS REMOVED AT THE BOTTOM. WHEN THE RESIN CAPACITY IS EXHAUSTED, THE COLUMN IS BACKWASHED TO REMOVE TRAPPED SOLIDS AND THEN REGENERATED. SUSPENDED SOLIDS IN THE FEED STREAM SHOULD BE LESS THAN 50 MG/L TO PREVENT PLUGGING THE RESINS. THE CATIONIC EXCHANGE RESIN IS REGENERATED WITH A STRONG ACID, SUCH AS SULFURIC ACID OR HYDROCHLORIC ACID. SODIUM HYDROXIDE IS A COMMONLY USED REGENERANT FOR ANION EXCHANGE RESIN. THIS PROCESS CAN TAKE PLACE IN SEPARATE EXCHANGE COLUMNS ARRANGED IN SERIES, OR BOTH RESINS CAN BE MIXED IN A SINGLE REACTOR (ELZEL AND TSENG, 1984).

FOR THE REDUCTION OF CR(VI) AND CR(III), BOTH ANIONIC AND CATIONIC EXCHANGE RESINS MUST BE USED. THE GROUND WATER IS FIRST PASSED THROUGH A CATION EXCHANGER WHERE THE POSITIVELY CHARGED IONS, SUCH AS CR (VI), ARE REPLACED BY HYDROGEN IONS. THE CATION EXCHANGER EFFLUENT IS THEN PASSED OVER AN ANIONIC EXCHANGE RESIN WHERE THE ANIONS ARE REPLACED BY HYDROXIDE IONS. THUS, THE CHROMIUM IONS ARE REPLACED BY HYDROGEN AND HYDROXIDE IONS THAT REACT TO FORM WATER MOLECULES.

HEXAVALENT CHROMIUM CAN BE SUCCESSFULLY RECOVERED USING ION EXCHANGE TREATMENT. BECAUSE OF FACTORS SUCH AS RESIN CAPACITY AND THE NUMBER OF TIMES THE RESIN CAN BE REGENERATED, THIS TECHNOLOGY IS USUALLY APPLICABLE ONLY TO THOSE SITUATIONS INVOLVING RELATIVELY LOW INFLUENT CONCENTRATIONS. REMOVAL EFFICIENCIES OF 90 TO 99 PERCENT HAVE BEEN REPORTED FOR THE TREATMENT OF GROUND WATER WITH A CONVENTIONAL TWO-STAGE EXCHANGER SYSTEM. EVEN HIGHER REMOVALS ARE POSSIBLE WITH MIXED-BED EXCHANGERS.

THE UNIT VOLUME COST FOR STRONG-BASE RESINS IS 3 TO 4 TIMES THAT OF STRONG-ACID RESINS. THE HIGHER COST OF STRONG-BASE RESINS IS DUE TO THE CONSIDERABLY MORE COMPLEX MANUFACTURING PROCESS REQUIRED FOR THE ANION RESINS.

THE ADVANTAGES OF THE ION EXCHANGE PROCESS ARE:

- SIMPLE, BASIC TYPE OF UNIT WITH EASY MAINTENANCE.

- BETTER QUALITY CONTROL DUE TO ELIMINATION OF PROCESS VARIABILITY.

- REDUCED WASTE DISPOSAL COSTS.

ION EXCHANGE HAS SIMILAR DISADVANTAGES TO CARBON ADSORPTION FOR APPLICATION TO THE TREATMENT OF GROUND WATER FROM THE SITE. SPECIFICALLY, THE ION EXCHANGE, REGENERATION, AND CHROMIUM PRECIPITATION OPERATIONS REQUIRE A VARIETY OF EQUIPMENT, CONTROLS, CHEMICALS, AND LABOR. THESE ITEMS RESULT IN HIGH CAPITAL AND OPERATIONAL COSTS. INCLUDED IN THESE EXPENSES IS THE HIGH COST OF ION EXCHANGE RESIN. IF BOTH CR(VI) AND CR(III) ARE PRESENT IN THE WASTEWATER, TWO RESIN BEDS WOULD BE REQUIRED BECAUSE CR(VI) ABSORBS ON ANION RESIN (CR+6 EXISTING AS CRO4-2) AND CR(III) ABSORBS ON CATION RESIN. REGENERATION AND PRECIPITATION OF CHROMIUM WOULD ALSO BE FURTHER COMPLICATED IF BOTH CR(III) AND CR(VI) ARE PRESENT IN THE GROUND WATER. THE MAJOR DISADVANTAGES OF THIS TECHNOLOGY ARE AS FOLLOWS:

- HIGH REGENERATION COST.
- FLUCTUATING EFFLUENT QUALITY.
- REQUIRES SUBSTANTIAL FLOOR SPACE.

THE CONSTRUCTION COST FOR A SYSTEM CAPABLE OF HANDLING 20 GPM, INCLUDING A STEEL CONTACT VESSEL,

A RESIN DEPTH OF 6 FEET, HOUSING FOR THE COLUMNS, AND ALL PIPING AND BACKWASH FACILITIES, IS ESTIMATED TO BE $84,000 WITH AN O&M COST OF $14,000. THE O&M COST INCLUDES ELECTRICITY FOR BACKWASHING AND PERIODIC REPAIR AND REPLACEMENT COSTS. COSTS FOR REGENERANT CHEMICALS ARE NOT INCLUDED BECAUSE THEY VARY DEPENDING ON THE CONCENTRATIONS OF CHROMIUM TO BE REMOVED FROM THE GROUND WATER.

7.1.3.6 REVERSE OSMOSIS

IF A PRESSURE EQUAL TO OR GREATER THAN THE OSMOTIC PRESSURE IS APPLIED TO THE SOLUTION SIDE OF A MEMBRANE, THE SOLVENT WILL FLOW ACROSS THE MEMBRANE LEAVING A MORE CONCENTRATED SOLUTION. THIS PROCESS IS KNOWN AS REVERSE OSMOSIS. SUFFICIENTLY HIGH PRESSURE, USUALLY IN THE RANGE OF 200 TO 400 PSI, WILL FORCE THE SOLVENT OUT OF SOLUTION, PRODUCING A MORE CONCENTRATED STREAM WHICH MUST BE TREATED FURTHER OR DISPOSED OF. IONS AND SMALL MOLECULES IN GROUND WATER CAN BE SEPARATED FROM WATER BY THIS TECHNIQUE. THE CONCENTRATED WASTE STREAM REQUIRES ADDITIONAL TREATMENT TO REMOVE OR RECOVER THE CHROMIUM.

THE BASIC COMPONENTS OF A REVERSE OSMOSIS UNIT ARE THE MEMBRANE, A MEMBRANE SUPPORT STRUCTURE, A CONTAINING VESSEL, AND A HIGH PRESSURE PUMP. THE MEMBRANE AND MEMBRANE SUPPORT STRUCTURE ARE THE MOST CRITICAL ELEMENTS. THE FACT THAT REVERSE OSMOSIS UNITS CAN BE OPERATED IN SERIES OR IN PARALLEL PROVIDES SOME FLEXIBILITY IN DEALING WITH INCREASED FLOW RATES OR CONCENTRATIONS OF DISSOLVED SPECIES.

AVAILABLE INFORMATION AND EXPERIENCE IS LIMITED REGARDING THE USE OF REVERSE OSMOSIS FOR GROUND WATER TREATMENT. A HEXAVALENT CHROMIUM REMOVAL EFFICIENCY OF 93.5 PERCENT HAS BEEN REPORTED FOR AN INFLUENT CONCENTRATION OF 49.6 MG/L (HINDIN, 1968). THE VOLUME OF THE REJECT GENERATED BY REVERSE OSMOSIS IS ABOUT 10 TO 25 PERCENT OF THE FEED VOLUME. PROVISIONS MUST BE MADE TO TREAT THIS POTENTIALLY HAZARDOUS WASTE. PRETREATMENT OF THE SECONDARY EFFLUENT WITH FILTRATION AND CARBON ADSORPTION IS USUALLY NECESSARY.

A VERY HIGH QUALITY FEED IS REQUIRED FOR EFFICIENT OPERATION OF A REVERSE OSMOSIS UNIT. THE REMOVAL OF IRON AND MANGANESE IS ALSO NECESSARY TO DECREASE SCALING POTENTIAL. THE PH OF THE FEED SHOULD BE ADJUSTED TO A RANGE OF 4.0 TO 7.5 TO INHIBIT SCALE FORMATION. THE PRIMARY LIMITATIONS OF REVERSE OSMOSIS ARE ITS HIGH COST AND THE PROBLEM OF A CONCENTRATED WASTE STREAM WHICH MUST BE TREATED FURTHER USING ANOTHER TECHNOLOGY. BECAUSE OF THE LOW REMOVAL EFFICIENCY AND HIGH QUALITY FEED REQUIREMENTS, REVERSE OSMOSIS IS NOT CONSIDERED TO BE APPLICABLE TO THE TREATMENT OF GROUND WATER AT THE CWP SITE.

THE TOTAL CAPITAL COST, INCLUDING HOUSING, TANKS, PIPING, MEMBRANES, FLOW METERS, CARTRIDGE FILTERS, ACID AND POLYPHOSPHATE FEED EQUIPMENT, AND CLEANUP EQUIPMENT, TO TREAT 20 GPM ARE ESTIMATED TO BE $400,000 WITH A TOTAL ANNUAL O&M COST OF $150,000. THE O&M COSTS INCLUDE ELECTRICITY FOR THE HIGH PRESSURE FEED PUMPS (450 PSI OPERATING PRESSURE), BUILDING UTILITIES, ROUTINE PERIODIC REPAIR, ROUTINE CLEANING, AND MEMBRANE REPLACEMENT EVERY THREE YEARS (EPA 600-8-80-042D).

7.1.3.7 ELECTRODIALYSIS

IN THE ELECTRODIALYSIS PROCESS, IONIC COMPONENTS OF A SOLUTION, SUCH AS CR (VI), ARE SEPARATED THROUGH THE USE OF SEMI-PERMEABLE ION-SELECTIVE MEMBRANES. APPLICATION OF AN ELECTRICAL POTENTIAL BETWEEN THE TWO ELECTRODES CAUSES ELECTRIC CURRENT TO PASS THROUGH THE SOLUTION, WHICH, IN TURN, CAUSES A MIGRATION OF CATIONS TOWARD THE NEGATIVE ELECTRODE AND A MIGRATION OF ANIONS TOWARD THE POSITIVE ELECTRODE. BECAUSE OF THE ALTERNATE SPACING OF CATION AND ANION PERMEABLE MEMBRANES, CELLS OF CONCENTRATED AND DILUTE SOLUTION ARE FORMED (POON AND LU, 1981).

GROUND WATER IS PUMPED THROUGH THE MEMBRANES WHICH ARE SEPARATED BY SPACERS AND ASSEMBLED INTO STAGES. THE RETENTION TIME IN EACH STAGE IS USUALLY ABOUT 10 TO 20 SECONDS. REMOVAL OF CHROMIUM FROM GROUND WATER VARIES WITH:

- GROUND WATER TEMPERATURE
- AMOUNTS OF ELECTRICAL CURRENT PASSED
- AMOUNT OF CR(VI) AND/OR CR(III) IONS
- FOULING AND SCALING POTENTIAL
- NUMBER AND CONFIGURATION OF STAGES.

THIS PROCESS MAY BE OPERATED IN EITHER A CONTINUOUS OR A BATCH MODE. THE UNITS CAN BE ARRANGED EITHER IN PARALLEL TO PROVIDE THE NECESSARY HYDRAULIC CAPACITY OR IN SERIES TO ACHIEVE THE DESIRED DEGREE OF CHROMIUM REMOVAL. MAKEUP WATER, USUALLY ABOUT 10 PERCENT OF THE FEED VOLUME, IS REQUIRED TO WASH THE MEMBRANES CONTINUOUSLY. A PORTION OF THE CONCENTRATE STREAM IS RECYCLED TO MAINTAIN NEARLY EQUAL FLOW RATES AND PRESSURES ON BOTH SIDES OF EACH MEMBRANE. SULFURIC ACID IS FED TO THE CONCENTRATE STREAM TO MAINTAIN A LOW PH AND, THUS, MINIMIZE SCALING.

TO ACHIEVE HIGH THROUGHPUT, ELECTRODIALYSIS CELLS IN PRACTICE ARE MADE VERY THIN AND ASSEMBLED IN STACKS OF CELLS IN SERIES. EACH STACK OF 10 CONSISTS OF MORE THAN 100 CELLS. GENERALLY, ELECTRODIALYSIS WORKS BEST ON ACIDIC STREAMS CONTAINING A SINGLE PRINCIPAL METAL ION.

AN ELECTRODIALYSIS PLANT PRODUCES TWO PRODUCT STREAMS, ONE DILUTE AND ONE CONCENTRATED, WHICH MAY NEED TO BE DISPOSED OR FURTHER TREATED. BECAUSE OF HYDROGEN GENERATION, THIS TECHNOLOGY MAY CAUSE SOME FOCAL AIR POLLUTION (EPA 600-8-80-042C).

ELECTRODIALYSIS HAS THE ADVANTAGE OF BEING A CONTINUOUS PROCESS WHICH, UNLIKE THE ADSORPTION PROCESS, DOES NOT REQUIRE REGENERATION. HOWEVER, ELECTRODIALYSIS IS USUALLY NOT ECONOMICAL FOR TREATMENT OF VERY DILUTE CHROMIUM SOLUTIONS LIKE THE CWP GROUND WATER AND FOR SITUATIONS WHERE LOW EFFLUENT CONCENTRATIONS ARE REQUIRED. A MORE COMMON APPLICATION FOR THIS TECHNOLOGY IS THE RECOVERY OF IONIZED SPECIES SUCH AS METAL SALTS, CYANIDES, OR CHROMATES FROM METAL FINISHING WASTEWATERS, WHICH ARE AT CONSIDERABLY HIGHER CONCENTRATIONS THAN THE GROUND WATER.

PROBLEMS ASSOCIATED WITH THE ELECTRODIALYSIS PROCESS INCLUDE CHEMICAL PRECIPITATION ON THE MEMBRANE SURFACE AND CLOGGING OF THE MEMBRANE BY THE RESIDUAL COLLOIDAL ORGANIC MATTER IN GROUND WATER. TO REDUCE MEMBRANE FOULING, ACTIVATED CARBON PRETREATMENT, POSSIBLY PRECEDED BY CHEMICAL PRECIPITATION AND SOME FORM OF MULTIMEDIA FILTRATION, MAY BE REQUIRED. THIS PROCESS MAY, THEREFORE, REQUIRE MORE ATTENTION AND MAINTENANCE THAN OTHER SYSTEMS DISCUSSED IN PREVIOUS SECTIONS. ALSO, THIS PROCESS IS NOT AN ESTABLISHED TECHNOLOGY FOR THE SUBJECT APPLICATION. IT IS STILL CONSIDERED TO BE POSSIBLY APPLICABLE TO THE TREATMENT OF GROUND WATER AT THE CWP SITE.

THE CAPITAL COST ASSOCIATED WITH THIS OPTION IS APPROXIMATELY $85,000. THE O&M COSTS ARE ESTIMATED AT $1.00 PER 1,000 GALLONS.

7.1.4 ALTERNATIVES FOR DISCHARGE OF EXTRACTED WATER

GROUND WATER EXTRACTION FOR PLUME CONTROL AND REMEDIATION REQUIRES AN APPROPRIATE MEANS OF HANDLING THE PUMPED WATER. THE OPTIONS CONSIDERED FOR HANDLING EXTRACTED GROUND WATER, EITHER WITH OR WITHOUT TREATMENT, ARE AS FOLLOWS:

- RECYCLING
- SANITARY SEWER DISCHARGE
- SURFACE WATER DISCHARGE
- SUBSURFACE INJECTION.

7.1.4.1 RECYCLING

THE MOST COST-EFFECTIVE METHOD OF HANDLING THE CONTAMINATED WATER IS TO RECYCLE THE PUMPED WATER INTO CWP OPERATIONS WITHOUT TREATMENT. THIS WOULD BE POSSIBLE SO LONG AS CWP'S DEMAND WAS LARGER THAN THE VOLUME EXTRACTED. OTHERWISE, PARTIAL RECYCLING COMBINED WITH TREATMENT/DISPOSAL OF THE BALANCE COULD BE PERFORMED.

TO EXPLORE THE POSSIBILITY OF RECYCLING, A REVIEW OF THE WATER BALANCE IS NECESSARY. THE TOTAL SURFACE WATER COLLECTION AREA IS 22,840 FT2. THUS, ONE INCH OF RAIN GENERATES 14,180 GALLONS OF RUNOFF. THE STORM EVENTS OF INTEREST AND THE CORRESPONDING VOLUME OF WATER ARE AS FOLLOWS (DEPARTMENT OF WATER RESOURCES, 1976):

STORM EVENT	RAINFALL (INCHES)	WATER (GALLONS)
10-YEAR WINTER	48.93	693,827
100-YEAR/24-HOUR	6.66	94,439

THE CWP OPERATION USES 20 ABOVE-GROUND TANKS WITH A TOTAL STORAGE CAPACITY OF 752,000 GALLONS. ASSUMING THE OCCURRENCE OF A 10-YEAR WINTER STORM, THE AVAILABLE STORAGE WILL AMOUNT TO 59,173 GALLONS (752,000 MINUS 693,827). THE DAILY OPERATIONAL USE IS ABOUT 8,000 GALLONS OR APPROXIMATELY 5.5 GPM. THEREFORE, IF THE EXTRACTION SYSTEM OPERATES AT ABOUT 5 GPM DURING DRY CONDITIONS, ALL THE EXTRACTED WATER CAN BE RECYCLED. ALSO, DURING THE STORM EVENTS (10-YEAR WINTER), EXTRACTION RATES OF 4 TO 6 GPM COULD BE ACCOMMODATED FOR ABOUT EIGHT DAYS UTILIZING THE AVAILABLE STORAGE.

IT IS EVIDENT FROM THE MASS BALANCE CALCULATIONS THAT FOR EXTRACTION RATES GREATER THAN 5 GPM OR DURING THE WET WINTER MONTHS, AN ADDITIONAL DISCHARGE OPTION IS REQUIRED. IT IS IMPORTANT TO NOTE THAT HIGHER EXTRACTION RATES ARE DESIRED DURING THE WET SEASON TO ACHIEVE A GREATER DEGREE OF MIGRATION CONTROL AND REMEDIATION.

7.1.4.2 DISCHARGE INTO THE SANITARY SEWER

DISCHARGE OF TREATED GROUND WATER INTO THE SANITARY SEWER IS A VIABLE OPTION WHICH IS CURRENTLY BEING PURSUED BY CWP. THIS OPTION HAS BEEN UNDER CONSIDERATION SINCE 1983, WHEN THE CITY OF UKIAH (THE CITY) INFORMED CWP OF THE REGULATIONS CONCERNING THE CRITERIA FOR DISCHARGING WASTEWATERS INTO THE SANITARY SEWER SYSTEM. UPON THE CITY'S REQUEST, KENNEDY/JENKS ENGINEERS WERE DIRECTED TO EVALUATE THE COMPATIBILITY OF TREATED WATER FROM THE CWP FACILITY WITH THE CITY'S WASTEWATER TREATMENT PLANT REGULATIONS. THE KENNEDY/JENKS ENGINEERS (MARCH 19, 1984) EVALUATION CONCLUDED THAT A DISCHARGE OF 40,000 GALLONS PER DAY OF WASTEWATER CONTAINING NO MORE THAN 0.5 MG/L OF HEXAVALENT CHROMIUM WOULD BE ACCEPTABLE UNDER THE LIMITATIONS OF RESTRICTED DISCHARGES. THE ACCEPTABILITY OF THE WASTEWATER DISCHARGE WOULD BE SUBJECT TO VERIFICATION OF THE EXISTING BASELINE (PRE-DISCHARGE) LEVELS OF CHROMIUM PRESENT IN THE CITY SEWAGE AND SLUDGE. THE BASELINE DATA WERE SUBSEQUENTLY GENERATED AND SUBMITTED TO THE CITY. ON APRIL 30, 1987, CWP SUBMITTED A PROPOSAL TO DISCHARGE THE ELECTROCHEMICALLY-TREATED WATER DURING THOSE PERIODS WHEN EXTRACTED GROUND WATER CANNOT BE RECYCLED OR STORED ON SITE (CWP, APRIL 30, 1987). THIS PROPOSAL PROVIDED THE REQUIRED BASELINE DATA AND THE ELECTROCHEMICAL TREATMENT UNIT INFLUENT AND EFFLUENT CHROMIUM CONCENTRATIONS. THE DATA PROVIDED DEMONSTRATED THAT THE EXISTING DISCHARGE LIMITATIONS CAN BE COMPLIED WITH. THE MAXIMUM CHROMIUM CONCENTRATION IN THE ELECTROCHEMICAL TREATMENT SYSTEM EFFLUENT WAS SPECIFIED AS 0.1 MG/L. THE CITY HAS PROVIDED CWP WITH AN AUTHORIZATION TO DISCHARGE SUBJECT TO CERTAIN PROVISIONS, PROHIBITIONS, AND REQUIREMENTS AS OUTLINED IN TABLE 15. CWP IS CURRENTLY REVIEWING THE CITY'S REQUIREMENTS.

7.1.4.3 DISCHARGE INTO THE SURFACE DRAINAGE SYSTEM

ANOTHER POSSIBLE METHOD OF HANDLING EXCESS TREATED WATER IS DISCHARGE TO THE SURFACE DRAINAGE DITCH TO THE EAST OF THE SITE. AS DISCUSSED IN SECTION 4.3, THIS DRAINAGE DITCH EVENTUALLY REPORTS TO THE RUSSIAN RIVER, ALTHOUGH SOME SEEPAGE INTO THE VALLEY FILL DEPOSITS IS LIKELY TO OCCUR. THE DITCH HAS THE CAPACITY TO ACCEPT EXCESS DISCHARGED WATER, EVEN DURING PEAK FLOW PERIODS. IMPLEMENTATION OF THIS OPTION WOULD ONLY BE POSSIBLE IF RESTRICTIONS ON DISCHARGE INTO THE RUSSIAN RIVER AND ITS TRIBUTARIES ARE RELAXED. THE PROBABLE DEVELOPMENT OF MORE STRINGENT DISCHARGE RESTRICTIONS DOES NOT MAKE THIS OPTION A PROMISING OR FEASIBLE ALTERNATIVE AT THIS TIME.

7.1.4.4 SUBSURFACE INJECTION

INJECTION OF EXCESS TREATED WATER INTO THE MORE PERMEABLE STRATA BENEATH THE SITE IS MORE APPROPRIATE DURING THE DRY SEASONS WHEN GROUND WATER LEVELS ARE GENERALLY LOWER. CWP HAS ATTEMPTED TO IMPLEMENT THIS OPTION BY INSTALLING INJECTION WELL CWP-19 UPGRADIENT OF THE CONTAMINATED ZONE. DURING THE WET WINTER MONTHS, HOWEVER, WHEN THE VOLUME OF WATER TO BE DISPOSED IS GREATEST, WELL CWP-19 HAS NOT BEEN ABLE TO ACCOMMODATE THE REQUIRED FLOW. DURING THE DRIER MONTHS WHEN GROUND WATER IS DEEPER, THIS DISCHARGE ALTERNATIVE MAY BE NECESSARY IN ORDER TO FLUSH THE CONTAMINANTS TOWARD THE EXTRACTION WELL. ONE OF THE MAJOR DISADVANTAGES OF THIS METHOD IS BIO-FOULING AND MICROBIAL GROWTH IN THE INJECTION WELLS, REQUIRING FREQUENT MAINTENANCE.

7.2 RECOMMENDED REMEDIAL ACTION

THIS SECTION DESCRIBES THE RECOMMENDED REMEDIAL ACTION BASED ON THE SCREENING OF VARIOUS ALTERNATIVES PRESENTED IN SECTION 7.3. THE RATIONALE FOR SELECTION OF THE RECOMMENDED ALTERNATIVE AND REJECTION OF THE OTHERS, AND A DESCRIPTION OF THE ENVIRONMENTAL EFFECTS OF THE

RECOMMENDED ALTERNATIVE ARE ALSO PROVIDED. THE COMPONENTS OF THE RECOMMENDED REMEDIAL ACTION PLAN ARE AS FOLLOWS:

- SURFACE RUNOFF MANAGEMENT
- CONTROL OF CONTAMINATED SOIL
- PLUME CONTROL AND AQUIFER REMEDIATION
- ELECTROCHEMICAL TREATMENT OF GROUND WATER
- WATER RECYCLING/DISCHARGE TO THE UKIAH SEWAGE TREATMENT PLANT OR REINJECTION
- MONITORING.

EACH OF THE ABOVE COMPONENTS IS DESCRIBED BELOW.

7.2.1 SURFACE RUNOFF FLOW MANAGEMENT

SURFACE RUNOFF SHALL BE CONTROLLED IN ORDER TO PREVENT THE DISCHARGE OF POTENTIALLY CONTAMINATED WATER TO SURFACE WATERS. THE REMAINING UNPAVED PORTIONS OF THE SITE SHALL BE PAVED. THE AREA LOCATED ADJACENT TO THE 330,000-GALLON STORAGE TANK SHALL ALSO BE REGRADED AND REPAVED TO PREVENT PONDING. THE SITE SHALL BE INSPECTED PERIODICALLY, AT LEAST ONCE PER YEAR BEFORE THE WET SEASON, AND SURFACE PAVING AND DRAINAGE FEATURES REPAIRED AS APPROPRIATE. PARTICULAR ATTENTION SHALL BE GIVEN TO AREAS AROUND THE SUMPS AND RETORTS. MOBILE EQUIPMENT (E.G., FORKLIFTS) SHALL BE DESIGNATED FOR EXCLUSIVE USE IN THE RETORT AREA, TREATED WOOD STORAGE AREA, OR UNTREATED WOOD STORAGE AREA TO PREVENT CROSS SURFACE CONTAMINATION. STORM WATER MONITORING SHALL BE PERFORMED IN ACCORDANCE WITH RWQCB ORDER NO. 85-101. THE RESULTS OF STORM WATER QUALITY MONITORING WILL BE EVALUATED AND APPROPRIATE ACTIONS TAKEN ACCORDINGLY.

7.2.2 CONTROL OF CONTAMINATED SOIL

THE CONTAMINATED SOIL SHALL BE CONTROLLED BY PREVENTING SURFACE WATER INFILTRATION AND BY EXERCISING HYDRAULIC CONTROL OF THE PLUME IN ZONE 1. AS DESCRIBED IN SECTION 5.0, THESE REMEDIAL MEASURES HAVE BEEN PARTIALLY IMPLEMENTED AT THE CWP SITE. SURFACE PAVING HAS BEEN INSTALLED TO PREVENT THE PASSAGE OF WATER THROUGH THE NEAR-SURFACE, CHROMIUM-CONTAINING SOIL. CONSEQUENTLY, THE SOIL IS NOT EXPECTED TO BE A SIGNIFICANT SOURCE OF CONTAMINATION BY SURFACE WATER INFILTRATION DURING THE OPERATION OF THE FACILITY. POSTCLOSURE REMEDIAL MEASURES INCLUDE ON-SITE TREATMENT OF THE CONTAMINATED SOIL TO A DEPTH OF 1.5 FEET FOR AREAS CONTAINING GREATER THAN 100 MG/KG OF TOTAL CHROMIUM AND 15 MG/KG OF ARSENIC. BENEATH AND AROUND THE RETORT AND SUMP AREAS, THE DEPTH OF EXCAVATION IS EXPECTED TO BE 5 FEET. TREATABILITY STUDIES WILL BE CONDUCTED PRIOR TO SELECTING THE FINAL SOIL REMEDY AT THE TIME OF CLOSURE OF THE FACILITY.

CONTAMINATED SOIL THAT COMES IN CONTACT WITH GROUND WATER DURING SEASONAL HIGH GROUND WATER CONDITIONS WILL BE CONTROLLED HYDRAULICALLY. THE HYDRAULIC CONTROL MEASURES INCLUDE GROUND WATER EXTRACTION NEAR THE RETORT AREA FROM WELL CWP-18 AND NEAR THE SITE BOUNDARY FROM WELL HL-7. DETAILS OF THE HYDRAULIC CONTROL MEASURES ARE PRESENTED IN SECTION 7.2.3. THE PROPOSED APPROACH SHALL PREVENT DIRECT HUMAN EXPOSURE TO CONTAMINATED SOIL, ELIMINATE THE CONTRIBUTION OF INFILTRATING SURFACE WATER TO GROUND WATER CONTAMINATION, AND PREVENT OFF-SITE MIGRATION. IMPLEMENTATION OF THESE MEASURES, COMBINED WITH PROPER TREATED WOOD HANDLING PRACTICES, SHOULD GRADUALLY IMPROVE THE SITE CONDITIONS. THE CRITERIA FOR EVALUATING SUCH IMPROVEMENTS INCLUDE THE TREND OF CHROMIUM CONCENTRATIONS IN WELLS LOCATED NEAR THE RETORT OR PROCESS AREA. IF NO IMPROVEMENT IS OBSERVED, ADDITIONAL INVESTIGATION AND REMEDIATION ACTIONS MAY BE REQUIRED.

BASED ON THE ABOVE CONSIDERATIONS AND AGENCIES PARTICIPATION IN THE SELECTION OF REMEDIAL ALTERNATIVES, TABLE 16 SUMMARIZES THE SOIL REMEDIAL ACTION ALTERNATIVES AS SUGGESTED BY DHS. AS SHOWN IN TABLE 16, ALTERNATIVE NO. 5.2, WHICH INCLUDES ON-SITE TREATMENT OF THE CONTAMINATED SOIL, IS FAVORED BY DHS.

7.2.3 PLUME CONTROL AND AQUIFER REMEDIATION

THE ZONE OF CONTAMINATION SHALL BE CONTROLLED HYDRAULICALLY TO PREVENT OFF-SITE MIGRATION AND TO GRADUALLY REMEDIATE THE AQUIFER. THIS WILL BE ACCOMPLISHED BY EXTRACTING GROUND WATER FROM

LOCATIONS NEAR THE RETORT AREA AND NEAR THE SITE BOUNDARY. A CONTINGENCY PLAN HAS ALSO BEEN DEVELOPED FOR OFF-SITE GROUND WATER EXTRACTION, SHOULD CHROMIUM CONCENTRATIONS EXCEED A PRESCRIBED LEVEL FOR PROLONGED PERIODS OF TIME. THE "ACTION LEVEL" AND PERSISTENCE OF CHROMIUM IN OFF-SITE WELLS ARE TO BE DECIDED BY THE REGULATORY AGENCIES.

EXTRACTION FROM NEAR THE RETORT AREA WILL BE PERFORMED THROUGH WELL CWP-18, WHICH INTERCEPTS THE CHROMIUM PLUME IN ZONE 1. ALTHOUGH THIS WELL CANNOT SUSTAIN CONTINUOUS PUMPING AT HIGH FLOW RATES, THE IMPACT OF INTERMITTENT PUMPING IS STILL BELIEVED TO BE SIGNIFICANT BECAUSE OF THE HIGH CHROMIUM CONCENTRATIONS IN GROUND WATER IN THAT AREA.

EXTRACTION FROM NEAR THE SITE BOUNDARY SHALL BE PERFORMED THROUGH WELL HL-7, LOCATED TO THE WEST (HYDRAULICALLY UPGRADIENT) OF THE SLURRY WALL. AS DESCRIBED IN SECTION 5.0, WELL HL-7 IS LOCATED AT THE CENTER OF A TRENCH WHICH IS ABOUT 20 FEET DEEP AND INTERCEPTS THE CHROMIUM PLUME APPROXIMATELY PERPENDICULAR TO THE DIRECTION OF GROUND WATER FLOW. EXTRACTION FROM WELL HL-7 CAN PRODUCE A ZONE OF INFLUENCE WHICH, IN EFFECT, CONTAINS THE CHROMIUM PLUME AND PREVENTS OFF-SITE MIGRATION. THE EXTRACTION RATE FROM WELL HL-7 SHALL VARY SEASONALLY FROM 5 TO 20 GPM, DEPENDING PRIMARILY ON GROUND WATER CONDITIONS. THE EXTRACTION OF GROUND WATER FROM WELL HL-7, COMBINED WITH THE PRESENCE OF THE SLURRY WALL, IS BELIEVED TO BE THE PRINCIPAL REMEDIATION MEASURE TO PREVENT THE OFF-SITE MIGRATION OF CHROMIUM.

IN ADDITION TO CONTAINING THE CHROMIUM PLUME ON SITE, GROUND WATER EXTRACTION, PARTICULARLY FROM WELL HL-7, WILL ALSO GRADUALLY REMEDIATE THE AFFECTED WATER-BEARING ZONE. AQUIFER REMEDIATION IS ACCOMPLISHED BY REMOVING CHROMIUM-CONTAINING WATER AND REPLACING IT WITH CHROMIUM-FREE WATER. TO ESTIMATE THE TIME REQUIRED TO REMEDIATE THE WATER-BEARING ZONE, THREE FACTORS HAVE BEEN CONSIDERED, AS FOLLOWS:

- THE TOTAL FLUID PRESENT IN THE WATER-BEARING ZONE CONTAINING ELEVATED CHROMIUM CONCENTRATIONS.
- THE NUMBER OF PORE VOLUMES REQUIRED TO ACHIEVE A GIVEN CONCENTRATION LIMIT.
- THE RATE OF GROUND WATER EXTRACTION.

BASED ON THE SITE-SPECIFIC CHARACTERISTICS AND A NUMBER OF ASSUMPTIONS, THE ABOVE PARAMETERS ARE DISCUSSED BELOW.

USING THE MOST RECENT AREAL DEFINITION OF THE CHROMIUM PLUME, THE AREA CONTAINED WITHIN THE 0.02 MG/L ISOCONCENTRATION IS ESTIMATED TO BE ABOUT 130,000 FT2. BASED ON THE ASSUMPTIONS THAT THE AVERAGE SATURATED THICKNESS OF THE WATER-BEARING ZONE IS 12 FEET AND ITS EFFECTIVE POROSITY IS 0.3, THE TOTAL FLUID PRESENT IN THE WATERBEARING ZONE IS ESTIMATED TO BE ABOUT 3.5 MILLION GALLONS. APPROXIMATELY 10 PORE VOLUMES ARE ESTIMATED TO BE REQUIRED TO REDUCE THE EXISTING CHROMIUM CONCENTRATIONS TO 0.05 MG/L. THIS ESTIMATE IS BASED ON THE FOLLOWING FACTORS AND ASSUMPTIONS:

- LABORATORY ADSORPTION TEST DATA OBTAINED FROM SITE-SPECIFIC SOIL SAMPLES (IT CORPORATION, JUNE 1985).
- HIGHER DESORPTION RATE UNDER FIELD CONDITIONS AS COMPARED TO LABORATORY CONDITIONS.
- POSSIBLE REACTIONS CAUSING FIXATION AND TRANSFORMATION OF CR(VI) TO MORE INSOLUBLE FORMS WITH TIME.
- PUBLISHED AND UNPUBLISHED DATA ON CR(VI) DESORPTION.
- INACCURACIES AND UNCERTAINTIES ASSOCIATED WITH DATA TRANSLATION FROM LABORATORY TO FIELD.

THE PUMPING RATE FROM WELL HL-7 COULD VARY FROM ABOUT 5 GPM TO 20 GPM, DEPENDING ON SEASONAL HYDROLOGIC CONDITIONS, THE WATER DEMAND BY CWP'S OPERATION, AND DISCHARGE CONSTRAINTS. ASSUMING AN AVERAGE PUMPING RATE OF 10 GPM FOR THE ENTIRE DURATION OF REMEDIATION, THE TIME REQUIRED TO REMOVE ONE PORE VOLUME IS ESTIMATED TO BE ABOUT 8.5 MONTHS. THUS, BASED ON THE ABOVE ASSUMPTIONS AND CONSIDERATIONS, THE ESTIMATED TIME OF AQUIFER CLEANUP IS ABOUT SEVEN YEARS.

IN THE ABOVE CALCULATION, IT IS ASSUMED THAT THE SOIL DOES NOT ACT AS A SOURCE OF CHROMIUM TO GROUND WATER. HOWEVER, THE CHROMIUM CONTAMINATED SOIL AT THE SITE MAY CONTINUE TO ACT AS A SOURCE OF CONTAMINATION. THEREFORE, THE ACTUAL LENGTH OF TIME FOR AQUIFER CLEANUP WILL BE GREATER THAN THAT CALCULATED ABOVE. FOR LONG-TERM BUDGETARY PURPOSES, THE DURATION OF AQUIFER CLEANUP IS PROJECTED TO BE BETWEEN 7 TO 20 YEARS. A MORE ACCURATE ESTIMATE OF AQUIFER CLEANUP TIME WOULD BE POSSIBLE PROVIDED GROUND WATER REMEDIATION IS MONITORED AND RESULTS EVALUATED. THUS, A LONG-TERM MONITORING PROGRAM (SECTION 7.2.6.3) IS NEEDED TO ESTABLISH THE PERFORMANCE OF THE REMEDIATION IN ORDER TO ASSURE THAT GROUND WATER CLEANUP OBJECTIVES ARE ACHIEVED.

HYDRAULIC TESTING OF WELL HL-7 HAS SHOWN THAT DURING THE WINTER MONTHS, WHEN GROUND WATER LEVELS ARE HIGHEST, IT IS POSSIBLE TO EXTRACT 20 GPM FROM WELL HL-7 (GEOSYSTEM, MARCH 1986). TO ACCOMMODATE HIGHER EXTRACTION RATES, DISCHARGE OF TREATED WATER INTO THE SANITARY SEWER WOULD BE REQUIRED.

BECAUSE OF THE OCCASIONAL APPEARANCE OF CHROMIUM IN WELL CWP-8, LOCATED TO THE EAST OF THE SLURRY, EXTRACTION FROM WELL CWP-8 IS PROPOSED. AT THE SAME TIME, THE PUMPING RATE OF WELL HL-7 MAY BE INCREASED TO PROVIDE A MORE EFFECTIVE HYDRAULIC BARRIER. EXTRACTION FROM WELL CWP-8, HOWEVER, WILL BE EFFECTIVE IN REDUCING OR ELIMINATING THE SOURCE OF CHROMIUM TO OFF-SITE AREAS. THE EXTRACTED WATER SHALL BE TRANSFERRED THROUGH A 3-INCH LINE TO THE SUMP, AS SHOWN IN FIGURE 19. THE WATER WILL BE TREATED AS DESCRIBED EARLIER. BASED ON CWP'S EXPERIENCE, DURING WET SEASONS IT IS POSSIBLE TO EXTRACT 3 TO 5 GPM CONTINUOUSLY FROM WELL CWP-8.

BECAUSE OF THE OCCASIONAL PRESENCE OF DISSOLVED CHROMIUM IN WELL AT-2 ABOVE 0.05 MG/L, A CONTINGENCY PLAN HAS BEEN DEVELOPED TO INITIATE OFF-SITE GROUND WATER EXTRACTION, IF NEEDED. THE CRITERIA FOR INITIATION OF OFF-SITE EXTRACTION ARE CURRENTLY BEING DEVELOPED BY THE REGULATORY AGENCIES, DEPENDING ON THE PERSISTENCE OF CHROMIUM ABOVE A PRESCRIBED CONCENTRATION.

THE OFF-SITE EXTRACTION PROGRAM SHALL INCLUDE PUMPING FROM WELL AT-2 OR A NEW EXTRACTION WELL IN THE SAME VICINITY. THE EXTRACTED WATER SHALL BE TRANSFERRED, VIA A 3-INCH UNDERGROUND PVC PIPE, TO THE ON-SITE SUMP, AS SHOWN IN FIGURE 19. THE OFF-SITE GROUND WATER QUALITY DATA INDICATE THAT PUMPING FROM WELL AT-2 WOULD MOST LIKELY BE INTERMITTENT, IF REQUIRED AT ALL.

BASED ON THE ABOVE CONSIDERATIONS AND AGENCIES PARTICIPATION IN REMEDIAL ALTERNATIVE SELECTION, A SUMMARY OF GROUND WATER REMEDIAL ACTION ALTERNATIVES SUGGESTED BY DHS IS PRESENTED IN TABLE 17. ALTERNATIVE NO. GW-3, WHICH INCLUDES HYDRAULIC CONTROL COMBINED WITH EXISTING PHYSICAL CONTAINMENT, IS FAVORED BY DHS.

7.2.4 ELECTROCHEMICAL TREATMENT OF GROUND WATER

EXTRACTED GROUND WATER IN EXCESS OF CWP'S WATER REQUIREMENTS SHALL BE TREATED USING THE EXISTING ELECTROCHEMICAL UNIT AT THE SITE. THIS UNIT IS MANUFACTURED BY ANDCO ENVIRONMENTAL SERVICES (ANDCO) AND IS CAPABLE OF HANDLING UP TO 150 GPM. HOWEVER, FOR GREATER EFFICIENCY, THE FLOW RATE SHALL BE MAINTAINED BELOW 50 GPM.

AS SHOWN IN FIGURE 19, THE EXTRACTED GROUND WATER SHALL BE PUMPED TO THE ON-SITE, CONCRETE-LINED SUMP, FROM WHICH IT WILL BE TRANSFERRED TO THE TREATMENT UNIT FOR PROCESSING. AFTER PROCESSING, THE WATER WILL ENTER THE HOLDING TANKS FOR PRECIPITATION AND RETREATMENT. SUBSEQUENTLY, THE WATER SHALL BE TRANSFERRED TO THE 330,000-GALLON TANK FOR SAMPLING PRIOR TO DISCHARGE. FROM THIS TANK, THE WATER WILL BE PUMPED THROUGH A 4-INCH PVC PIPELINE, PARALLEL TO TAYLOR DRIVE, AND INTO THE SEWER MAIN AT PLANT ROAD.

THE ANDCO CHROMATE REMOVAL SYSTEM EMPLOYS A PATENTED ELECTROCHEMICAL PROCESS DESIGNED TO REDUCE TOTAL CHROMIUM CONCENTRATIONS TO LESS THAN 0.05 MG/L. THE PROCESS REDUCES SOLUBLE HEXAVALENT CHROMIUM TO TRIVALENT CHROMIUM, WHICH IS PRECIPITATED AS HYDROXIDE, AS DISCUSSED IN SECTION 7.1.3.1. THE PRECIPITATE CAN THEN BE REMOVED FROM THE WASTE STREAM BY FILTRATION OR SEDIMENTATION, YIELDING AN EFFLUENT CONTAINING LESS THAN 0.05 MG/L CHROMIUM. TESTS PERFORMED BY CWP HAVE DEMONSTRATED THAT THE EFFLUENT CONCENTRATION OF CHROMIUM IS GENERALLY LESS THAN 0.04 MG/L. SELECTED DATA OBTAINED FROM CWP ARE AS FOLLOWS:

DATE	INFLUENT CONCENTRATION (MG/L)	EFFLUENT CONCENTRATION (MG/1)
3/06/84	5.3	0.02
13/05/84	6.8	0.02
11/06/84 (SAMPLE I)	169	0.02
13/06/84 (SAMPLE 2)	160	0.07

THE ANDCO CHROMATE REMOVAL SYSTEM CONSISTS OF TWO ELECTROCHEMICAL CELLS CONNECTED IN SERIES, TWO SEPARATE DC POWER SOURCES CONTAINED IN ONE CABINET, AND AN ACID WASH SYSTEM. THE CELL HOUSINGS AND ACID TANK ARE CONSTRUCTED OF FIBERGLASS AND ALL INTERCONNECTING PIPING IS OF PVC. THE INCOMING STREAM PASSES INTO THE FIRST CELL VIA A 3-INCH LINE WHICH INCLUDES A FLOW METER AND A PRESSURE GAUGE. THE STREAM THEN PASSES THROUGH THE SECOND CELL AND EXITS VIA A THREE-WAY VALVE FOR DIRECT DISCHARGE FROM THE TREATMENT STREAM. A SECOND PRESSURE GAUGE IS INCLUDED IN THE DISCHARGE LINE. A STRAINER AND GAS RELIEF VALVE ARE FITTED TO THE TOP OF EACH CELL TO PROVIDE A RELEASE FOR HYDROGEN GENERATED DURING THE ELECTROCHEMICAL PROCESS AND SHUTOFF DURING ACID WASHING. THE BOTTOM OF EACH CELL IS PIPED TO THE ACID PUMP FOR DRAINAGE PRIOR TO AND AFTER ACID WASHING AND FOR DRAINAGE PRIOR TO CELL REPLACEMENT (ANDCO, JUNE 1987).

THE ACID WASH SYSTEM CONSISTS OF AN ACID STORAGE TANK, ACID PUMP, AND INTERCONNECTING PIPING TO ALLOW ACID WASHING OF THE CELLS ON A DAILY BASIS. ACID WASHING PREVENTS COATING OF THE ELECTRODE SURFACES AND THE CORRESPONDING LOSS IN TREATMENT SYSTEM EFFICIENCY. THE PROCEDURE IS RELATIVELY SIMPLE TO PERFORM AND REQUIRES ONLY ABOUT IS MINUTES PER DAY TO ACCOMPLISH. TWO TO THREE TIMES A WEEK, THE ACID CONCENTRATION SHOULD BE CHECKED AND KEPT TO 8 TO 10 PERCENT BY THE ADDITION OF FRESH MURIATIC ACID. ON A MONTHLY BASIS, THE SPENT ACID CAN BE NEUTRALIZED AND BLED INTO THE DISCHARGE LINE AND NEW ACID MADE UP. THE ELECTRODE PLATES HAVE A NORMAL LIFE OF ABOUT ONE MILLION GALLONS AT AN INFLUENT CONCENTRATION OF 10 TO 11 MG/L OF CR(VI).

SUBSEQUENT TO THE INITIAL TREATMENT, THE WATER SHALL BE TRANSFERRED TO HOLDING TANKS, LOCATED NORTH OF THE TANK FARM, WHERE THE METAL HYDROXIDES ARE PRECIPITATED. AFTER PRECIPITATION IS COMPLETED, THE WATER COULD BE PASSED THROUGH THE TREATMENT UNIT A SECOND TIME TO ASSURE COMPLIANCE WITH EFFLUENT LIMITATIONS. THE EFFLUENT SHALL BE TRANSFERRED TO THE 330,000-GALLON TANK FOR TESTING AND STORAGE PRIOR TO DISCHARGE. THE TANK IS CONNECTED TO THE SANITARY SEWER LOCATED AT THE INTERSECTION OF TAYLOR DRIVE AND PLANT ROAD (FIGURE 19). THE RESULTING SLUDGE SHALL BE HANDLED ACCORDING TO THE APPROPRIATE EPA AND DHS REGULATIONS.

7.2.5 WATER REUSE/DISCHARGE TO THE UKIAH SEWAGE TREATMENT PLANT OR REINJECTION

EXTRACTED GROUND WATER WILL BE RECYCLED INTO CWP'S WOOD PRESERVING OPERATIONS TO THE EXTENT POSSIBLE. EXCESS GROUND WATER WHICH CANNOT BE RECYCLED INTO THE WOOD PRESERVING OPERATIONS WILL BE TREATED ELECTROCHEMICALLY, AS DESCRIBED IN THE PREVIOUS SECTION, AND DISCHARGED. AMONG THE VIABLE DISCHARGE OPTIONS CONSIDERED IN SECTION 7.1.4, DISCHARGE INTO THE SANITARY SEWER DURING THE WET MONTHS OR REINJECTION DURING THE DRY MONTHS APPEAR TO BE THE MOST PRACTICAL METHODS. DISCHARGE TO THE UKIAH SEWAGE TREATMENT PLANT MUST MEET PRETREATMENT REQUIREMENTS. ON DECEMBER 23, 1987, A DRAFT PERMIT TO DISCHARGE PRETREATED GROUND WATER WAS ISSUED BY THE CITY. THE DRAFT DOCUMENT OUTLINES THE REQUIREMENTS WHICH NEED TO BE MET PRIOR TO ALLOWING CWP TO DISCHARGE THE TREATED GROUND WATER. CWP HAS PROPOSED TO DISCHARGE TREATED WATER IN A BATCH BODE AFTER MONITORING. THE INITIAL MONITORING PROGRAM, AS SPECIFIED BY THE CITY, IS PRESENTED IN TABLE 15. CWP IS CURRENTLY REVIEWING THE DRAFT DOCUMENT AND PREPARING A RESPONSE.

7.2.6 MONITORING

MONITORING IS AN INTEGRAL PART OF REMEDIATION TO DOCUMENT THE PERFORMANCE AND EFFICIENCY OF THE EXTRACTION/TREATMENT SYSTEM. BASED ON THE MONITORING RESULTS, RECOMMENDATIONS AND MODIFICATIONS SHALL BE MADE FOR FURTHER SITE IMPROVEMENTS, AS APPROPRIATE. VARIOUS ELEMENTS OF THE PROPOSED MONITORING PROGRAM ARE DESCRIBED BELOW.

7.2.6.1 AIR QUALITY MONITORING

THE RECOMMENDED REMEDIAL ACTION DOES NOT REQUIRE AIR MONITORING; HOWEVER, AS PART OF ROUTINE WOOD PRESERVING OPERATIONS, AIR QUALITY IS MONITORED ON A PERIODIC BASIS. AIR QUALITY MONITORING PERTINENT TO RAP REQUIREMENTS SHALL BE EVALUATED IF CONTAMINATED SOIL IS TO BE EXCAVATED FOR REMEDIATION OR OTHERWISE DISTURBED. THE AIR QUALITY MONITORING PLAN WILL BE PART OF THE OVERALL HEALTH AND SAFETY PLAN AND ACCORDING TO OSHA REQUIREMENTS.

7.2.6.2 STORM WATER MONITORING

STORM WATER MONITORING, AS SPECIFIED BY THE RWQCB, SHALL BE PERFORMED AT STATIONS NE, NW, AND C-100, THE LOCATIONS OF WHICH ARE SHOWN IN FIGURE 2. THESE LOCATIONS HAVE BEEN SELECTED TO PROVIDE AN INDICATION OF THE QUALITY OF SURFACE RUNOFF FROM THE CWP SITE. THIS IS OF IMPORTANCE, AS THE SURFACE DRAINAGE SYSTEM ULTIMATELY DRAINS INTO THE RUSSIAN RIVER. STORM WATER SAMPLES SHALL BE COLLECTED ONCE PER MONTH DURING ANY PRECIPITATION EVENT SUFFICIENT TO PRODUCE A FLOW OF WATER IN THE SUBJECT DITCHES. THE SAMPLES SHALL BE ANALYZED FOR DISSOLVED TOTAL CHROMIUM AND ARSENIC. STORM WATER MONITORING RESULTS SHALL BE COMPILED AND REPORTED TO THE RWQCB AS SPECIFIED IN REVISED MONITORING AND REPORTING PROGRAM NO. 85-101 (RWQCB MAY 1987). THE RESULTS SHALL BE EVALUATED AND RECOMMENDATIONS AND MODIFICATIONS REGARDING OVERALL FACILITY IMPROVEMENTS SHALL BE MADE AS APPROPRIATE.

7.2.6.3 GROUND WATER MONITORING

A GROUND WATER MONITORING PROGRAM (RWQCB, MAY 1987) IS IN EFFECT TO EVALUATE THE GROUND WATER FLOW REGIME AND THE DISTRIBUTION OF CHROMIUM THROUGHOUT THE STUDY AREA. MONITORING INCLUDES GROUND WATER LEVEL MEASUREMENTS AND GROUND WATER QUALITY SAMPLING/ ANALYSIS. THE GROUND WATER MONITORING RESULTS SHALL BE USED TO EVALUATE THE EFFECTIVENESS OF THE HYDRAULIC CONTROL MEASURES IMPLEMENTED. RECOMMENDATIONS REGARDING ADDITIONAL MITIGATION MEASURES WILL BE MADE AS APPROPRIATE.

THE GROUND WATER SAMPLES WILL BE ANALYZED FOR TOTAL CHROMIUM AS SPECIFIED IN REVISED MONITORING AND REPORTING PROGRAM NO. 85-101, (RWQCB, MAY 1987). THE MONITORING SHALL BE PERFORMED ACCORDING TO THE PROCEDURES OUTLINED IN THE "GROUND WATER/STORM WATER MONITORING PROTOCOL" (GEOSYSTEM, AUGUST 1987, OR ITS SUBSEQUENT REVISIONS) PREPARED SPECIFICALLY FOR THE CWP FACILITY.

THE RESULTS OF THE GROUND WATER MONITORING SHALL BE REVIEWED ON A QUARTERLY BASIS AND REPORTED TO THE RWQCB AS REQUIRED BY REVISED MONITORING AND REPORTING PROGRAM NO. 85-101 (RWQCB, MAY 1987). BASED ON THE EVALUATION OF THE MONITORING RESULTS, RECOMMENDATIONS AND MODIFICATIONS SHALL BE MADE AS APPROPRIATE AND SUBJECT TO RWQCB APPROVAL.

7.2.6.4 TREATMENT SYSTEM MONITORING

DURING THE OPERATION OF THE ELECTROCHEMICAL UNIT, THE INFLUENT AND EFFLUENT CONCENTRATIONS SHALL BE MONITORED FOR HEXAVALENT CHROMIUM AND TOTAL CHROMIUM. THE MONITORING FREQUENCY SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE UKIAH SEWAGE TREATMENT PLANT, AS OUTLINED IN TABLE 15.

7.3 REASONS FOR SELECTION OF THE RECOMMENDED REMEDIAL ACTION

ENVIRONMENTAL AND PUBLIC HEALTH CRITERIA AND COST WERE THE PRINCIPAL CONSIDERATIONS IN THE SELECTION OF THE PROPOSED REMEDIAL ACTION PLAN. SPECIFIC REASONS FOR SELECTION OF VARIOUS COMPONENTS OF THE PLAN ARE AS FOLLOWS:

- PAVING OF THE AREAS OF SOIL IN WHICH HIGHER CHROMIUM CONCENTRATIONS HAVE BEEN MEASURED PREVENTS SURFACE WATER INFILTRATION AND REDUCES THE POTENTIAL FOR LEACHING OF CHROMIUM.

- ON-SITE TREATMENT OF SOIL AFTER SITE CLOSURE PROVIDES A PERMANENT REMEDY FOR THE CONTAMINATED SOIL.

- EXTRACTION FROM RECOVERY WELL CWP-18 REMOVES CHROMIUM-CONTAINING GROUND WATER IN AREAS WHERE CHROMIUM CONCENTRATIONS ARE HIGHEST, THUS REDUCING THE SOURCE TO DOWNGRADIENT AREAS.

- EXTRACTION FROM WELL HL-7, IN COMBINATION WITH THE SLURRY CUTOFF WALL, IS EFFECTIVE IN CONTAINING THE CHROMIUM PLUME ON SITE AND GRADUALLY REMEDIATING THE AQUIFER.

- EXTRACTION FROM WELL CWP-8 WOULD CONTAIN ANY RESIDUAL CHROMIUM TO THE EAST OF THE SLURRY WALL AND PREVENT FURTHER DOWNGRADIENT MIGRATION TO OFFSITE AREAS.

- USE OF THE ELECTROCHEMICAL UNIT IS AN ENVIRONMENTALLY AND ECONOMICALLY SOUND APPROACH FOR GROUND WATER TREATMENT.

- DISCHARGE OF THE TREATED WATER INTO THE UKIAH SEWAGE TREATMENT PLANT IS THE MOST FLEXIBLE AND ENVIRONMENTALLY SOUND APPROACH.

- THE PROPOSED MONITORING PLAN PROVIDES SUFFICIENT DATA TO DEMONSTRATE THE EFFECTIVENESS OF THE REMEDIAL ACTION PLAN AND TO IDENTIFY THE NEED FOR ADDITIONAL REMEDIAL ACTIONS, IF ANY.

THE REASONS FOR REJECTING OTHER ALTERNATIVES ARE BROADLY CATEGORIZED AS FOLLOWS:

- MARGINAL ENVIRONMENTAL ENHANCEMENT AT THE EXPENSE OF AN "ORDER OF MAGNITUDE" INCREASE IN COST, AS ILLUSTRATED BY COST ESTIMATES FOR SOIL REMOVAL.

- ENVIRONMENTAL UNACCEPTABILITY AND LACK OF PROVEN TECHNOLOGY FOR ALL HYDRAULIC CONTROL MEASURES EXCEPT THE SELECTED OPTION.

- TECHNICAL DIFFICULTIES FOR GROUND WATER INJECTION DURING WET SEASONS.

- INEFFICIENCY AND RELATIVE HIGH COST ASSOCIATED WITH OTHER TREATMENT TECHNOLOGIES COMPARED WITH THE ELECTROCHEMICAL PROCESS.

7.4 ENVIRONMENTAL EFFECTS OF THE SELECTED REMEDIAL ACTION

IN GENERAL, THE SELECTED REMEDIAL PLAN WILL MINIMIZE POTENTIAL ADVERSE IMPACTS ON HUMAN HEALTH AND THE ENVIRONMENT. THE SPECIFIC FEATURES OF THE REMEDIAL PLAN, WITH RESPECT TO ENVIRONMENTAL EFFECTS, ARE DESCRIBED BELOW.

7.4.1 CONTROL OF CONTAMINATED SOIL

ROUTINE MAINTENANCE OF SURFACE PAVING OVER AREAS OF SOIL CONTAMINATION SHALL PREVENT DIRECT EXPOSURE TO CONTAMINATED SOIL AND MINIMIZE THE INFILTRATION OF SURFACE WATERS. CONSEQUENTLY, THE TOP 1 TO 2 FEET OF THE SOIL PROFILE, WHICH HAVE BEEN SHOWN TO CONTAIN ELEVATED CONCENTRATIONS OF CHROMIUM AND ARSENIC, WILL NOT ACT AS A MAJOR SOURCE OF GROUND WATER CONTAMINATION. THE POST CLOSURE REMEDIATION PROVIDES A PERMANENT REMEDY FOR THE ON-SITE CONTAMINATED SOILS.

7.4.2 PLUME CONTROL

THE TWO MAJOR OBJECTIVES OF PLUME CONTROL ARE PREVENTING OFF-SITE MIGRATION AND REMEDIATING EXISTING CONTAMINATION IN THE ON-SITE WATER-BEARING ZONE. OFF-SITE MIGRATION IS CONTROLLED BY THE COMBINATION OF THE SLURRY CUTOFF VAIL AND EXTRACTION OF GROUND WATER FROM WELLS HL-7 AND CWP-8. ON-SITE REMEDIATION IS ACCOMPLISHED BY GROUND WATER EXTRACTION FROM WELLS HL-7 AND CWP-18. WATER QUALITY DATA HAVE DEMONSTRATED THAT THESE HYDRAULIC CONTROL MEASURES HAVE BEEN EFFECTIVE IN PREVENTING THE OFF-SITE MIGRATION OF CHROMIUM. SUBSEQUENT TO CONSTRUCTION OF THE SLURRY WALL IN OCTOBER 1983, CHROMIUM CONCENTRATIONS IN OFF-SITE WELLS HAVE GENERALLY DECREASED WITH TIME, AS DESCRIBED IN SECTION 4.5.3.

BASED ON THE CURRENT CHROMIUM CONCENTRATIONS IN OFF-SITE WELLS AND THE CONTINUING TREND OF DECREASING CHROMIUM CONCENTRATIONS, NO REMEDIATION IS PROPOSED FOR OFF-SITE AREAS. HOWEVER, A CONTINGENCY PLAN IS DEVELOPED TO ADDRESS OFF-SITE REMEDIATION WHEN THE CRITERIA FOR SUCH REMEDIATION ARE ESTABLISHED BY THE REGULATORY AGENCIES. TO DEMONSTRATE THE POTENTIAL ENVIRONMENTAL IMPACTS OF SELECTION OF THE "NO ACTION" ALTERNATIVE FOR OFF-SITE AREAS, THE TRANSPORT OF CHROMIUM WAS SIMULATED USING A TWO-DIMENSIONAL AREAL MODEL (GEOSYSTEM, APRIL 1987). DETAILS OF THIS MODELING EFFORT ARE PRESENTED IN APPENDIX E. THE MODEL RESULTS DEMONSTRATED THE FOLLOWING:

- UNDER PRESENT CONDITIONS, DOWNGRADIENT RECEPTORS WILL NOT BE ADVERSELY IMPACTED.

- DISPERSION AND ATTENUATION MECHANISMS WILL CONTINUE TO REDUCE CHROMIUM CONCENTRATIONS IN DOWNGRADIENT AREAS.

7.4.3 MONITORING

THE PROPOSED MONITORING PROGRAM IS DESIGNED TO DETECT ANY SIGNIFICANT ENVIRONMENTAL CHANGES AND TO PROVIDE EARLY WARNING TO THE RESPONSIBLE PARTIES. USING THE MONITORING DATA, THE EFFECTIVENESS OF THE PROPOSED REMEDIAL ACTION PLAN SHALL BE EVALUATED. THIS EVALUATION SHALL BE USED AS A BASIS FOR MODIFICATION OF THE REMEDIAL ACTION PLAN, IF NECESSARY.

7.5 APPLICABLE LAWS AND REGULATIONS

THE CWP SITE IS INCLUDED ON THE STATE SUPERFUND AND NATIONAL PRIORITY LISTS AND IS, THUS, SUBJECT TO BOTH STATE AND FEDERAL LAWS AND REGULATIONS. ALTHOUGH THE MORE FORMAL AND SYSTEMATIC SOIL AND GROUND WATER QUALITY INVESTIGATIONS AT THE SITE BEGAN IN JUNE 1980, A CERTAIN AMOUNT OF MONITORING WAS PERFORMED IN THE 1970S BY THE RWQCB. DURING THE EARLY PHASES OF THE INVESTIGATIONS, HOWEVER, MANY OF THE CURRENT REGULATIONS AND GUIDELINES WERE NOT IN EFFECT. THEREFORE, INVESTIGATION AND REMEDIATION ACTIVITIES WERE NOT ALWAYS PERFORMED IN ACCORDANCE WITH THE STATE AND FEDERAL LAWS CURRENTLY IN EFFECT. CERTAIN ACTIVITIES WERE PERFORMED BY CWP WITHOUT AUTHORIZATION OF THE REGULATORY AGENCIES (APPENDIX A).

AS REQUIRED BY THE NATIONAL CONTINGENCY PLAN (NCP 1985) AND SUPERFUND AMENDMENT AND REAUTHORIZATION ACT (SARA 1986), APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) HAVE BEEN USED AS A GUIDE TO EVALUATE THE APPROPRIATE EXTENT OF SITE CLEANUP, SELECT APPROPRIATE REMEDIAL ACTION ALTERNATIVES, AND HAS BEEN AND WILL BE USED IN IMPLEMENTATION AND OPERATION OF THE SELECTED REMEDIAL ACTION. AS REQUIRED BY SARA, STATE REQUIREMENTS THAT ARE MORE STRINGENT THAN FEDERAL REQUIREMENTS MUST GENERALLY BE ATTAINED IN IMPLEMENTATION OF REMEDIAL ACTIONS. THESE LAWS AND REGULATIONS ARE AS FOLLOWS:

- COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA) OF 1980, AS AMENDED BY THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986.

- RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) OF 1976, AMENDED BY THE HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984 (RCRA OR HSWA).

- SAFE DRINKING WATER ACT.

- CALIFORNIA CODE OF REGULATIONS, TITLE 22, DIVISION 4: ENVIRONMENTAL HEALTH (CHAPTER 1, ARTICLE 1; CHAPTER 2, ARTICLE 1; CHAPTER 30), JULY 1986.

- CALIFORNIA HEALTH AND SAFETY CODE.

- NORTH COASTAL BASIN WATER QUALITY CONTROL PLAN ADOPTED BY THE RWQCB.

- ALL ORDERS, INCLUDING SPECIFICATIONS, PROVISIONS, PROHIBITIONS, AND REQUIREMENTS ISSUED BY THE RWQCS.

- COURT ORDER BY THE STATE OF CALIFORNIA, OFFICE OF THE ATTORNEY GENERAL.

- NATIONAL CONTINGENCY PLAN, PERTINENT HAZARDOUS WASTE REGULATIONS UNDER 40 CFR, PARTS 260 TO 265; PART 300-68, JULY 1985.

- PORTER-COLOGNE WATER QUALITY CONTROL ACT, 1969.

BASED ON A REQUEST MADE BY DHS, A DRAFT OF THE DEED OF RESTRICTION ON REAL PROPERTY IS UNDER PREPARATION AND WILL BE INCLUDED AS APPENDIX G TO THIS DOCUMENT.

#**ISH**
8.0 IMPLEMENTATION SCHEDULE

AS MENTIONED IN-SECTION 5.0, THE INTERIM REMEDIAL MEASURES PROGRAM HAS BEEN IN EFFECT FOR SOME TIME. THEREFORE, A NUMBER OF ELEMENTS OF THE RECOMMENDED REMEDIAL ACTION PLAN HAVE ALREADY BEEN IMPLEMENTED. ACCORDING TO CWP, PUMPS AND PIPING ASSOCIATED WITH GROUND WATER EXTRACTION FROM WELLS CWP-18, HL-7, AND CWP-8 ARE IN PLACE AND IN OPERATING CONDITION. ALSO, THE ELECTROCHEMICAL UNIT IS ON SITE AND IN OPERATING CONDITION.

SUBSEQUENT TO APPROVAL OF THE RAP, THE FOLLOWING ACTIVITIES NEED TO BE COMPLETED PRIOR TO FULL-SCALE OPERATION:

- FINAL PERMIT FROM THE CITY FOR DISCHARGE OF TREATED WATER INTO THE SANITARY SEWER.

- CONNECTING THE LINE TO THE SEWER SYSTEM.

- PERMITTING, DESIGN, AND CONSTRUCTION OF OFF-SITE EXTRACTION SYSTEM, IF NEEDED.

- SYSTEM STARTUP AND TESTING.

BECAUSE OF UNCERTAINTIES ASSOCIATED WITH THE TIME OF APPROVAL OF THE RAP AND OBTAINING THE PERMIT TO DISCHARGE INTO THE SANITARY SEWER, THE REAL TIME SCHEDULE IS NOT KNOWN. CONNECTING THE LINE TO THE SEWER SYSTEM, CONSTRUCTION OF THE OFF-SITE EXTRACTION SYSTEM, IF NEEDED, AND SYSTEM STARTUP CAN BE COMPLETED WITHIN A THREE-MONTH PERIOD.

#**AFR**
9.0 ALLOCATION OF FINANCIAL RESPONSIBILITY AND PROVISIONS FOR FINANCIAL ASSURANCE

ALLOCATION OF FINANCIAL RESPONSIBILITY AND PROVISIONS FOR FINANCIAL ASSURANCE ARE BEING NEGOTIATED WITH THE REGULATORY AGENCIES AND WILL BE INCLUDED IN THE RAP IN THE NEAR FUTURE.

#**OMR**
10.0 OPERATION AND MAINTENANCE REQUIREMENTS

OPERATION AND MAINTENANCE (O&M) REQUIREMENTS WILL BE DEVELOPED SUBSEQUENT TO SYSTEM DESIGN, INSTALLATION, AND STARTUP. THESE REQUIREMENTS SHALL BE OUTLINED IN AN OPERATION AND MAINTENANCE MANUAL. HOWEVER, THE GENERAL O&M REQUIREMENTS RELATED TO THE FOLLOWING COMPONENTS AND FEATURES OF THE RECOMMENDED REMEDIAL ACTION ARE BRIEFLY DESCRIBED.

- GROUND WATER EXTRACTION
- GROUND WATER TREATMENT
- GENERAL SYSTEM INSPECTION AND MONITORING
- GENERAL SAFETY PROCEDURES
- EVALUATION OF SYSTEM EFFECTIVENESS
- REPORTING.

10.1 GROUND WATER EXTRACTION

DURING THE STARTUP PERIOD, FLOW ADJUSTMENTS SHALL BE MADE IN ACCORDANCE WITH CWP'S WATER RECYCLING REQUIREMENTS AND LIMITS OF TREATED WATER DISCHARGE. HOWEVER, ATTEMPTS WILL BE MADE TO MAXIMIZE EXTRACTION RATES FOR MORE EFFECTIVE HYDRAULIC CONTROL AND REMEDIATION. PROVISIONS MUST BE MADE TO RECORD THE EXTRACTION RATE AND CUMULATIVE FLOW FROM EACH EXTRACTION WELL.

DURING NORMAL OPERATION, THE O&M REQUIREMENTS INCLUDE FLOW ADJUSTMENT AND RECORDING, MAINTENANCE OF PUMPS AND PIPELINES, CALIBRATION OF GAUGES AND FLOW TOTALIZERS, PERIODIC SYSTEM INSPECTION, AND RECORD KEEPING. THE O&M MANUAL SHOULD PROVIDE DETAILED PROCEDURES FOR FLOW CONTROL AND DATA RECORDING DURING SYSTEM OPERATION.

10.2 GROUND WATER TREATMENT

ANDCO ENVIRONMENTAL SERVICES, INC. HAS PROVIDED CWP WITH PROCEDURES FOR OPERATING THE ELECTROCHEMICAL UNIT EXISTING AT THE SITE. SOME OF THE OPERATIONAL FEATURES OF THE UNIT ARE SUMMARIZED IN SECTION 7.2. THE ANDCO OPERATING PROCEDURES OUTLINE THE FOLLOWING STEPS WITH

SUFFICIENT DETAIL FOR IMPLEMENTATION:

- STARTUP OPERATION
- DAILY ACID WASHING AND POLARITY CHANGING
- SPENT ACID DISPOSAL
- ACID MAKEUP
- SHUTDOWN
- ELECTRODE REPLACEMENT
- PRECAUTIONS.

SINCE INSTALLATION OF THE ELECTROCHEMICAL UNIT, CWP HAS MADE SOME MODIFICATIONS TO IMPROVE ITS OPERATION. THE OPERATOR OF THE EXTRACTION/TREATMENT SYSTEM SHALL BE FAMILIAR WITH THESE MODIFICATIONS.

10.3 SYSTEM INSPECTION AND MONITORING

IT IS RECOMMENDED THAT THE GROUND WATER EXTRACTION/TREATMENT SYSTEM BE INSPECTED ONCE PER DAY. THE INSPECTION SHOULD INCLUDE THE EXTRACTION WELL PIPING AND INSTRUMENTATION; PIPELINES TRANSFERRING CONTAMINATED WATER TO THE SUMP; MAIN HEADER TO THE SEWER SYSTEM; AND TREATMENT SYSTEM UNIT, PIPES, AND INSTRUMENTATION. FLOW TOTALIZER READINGS AT THE EXTRACTION WELLS AND THE TREATMENT SYSTEM INFLUENT LINE SHOULD BE RECORDED.

SYSTEM MONITORING SHOULD BE PERFORMED ACCORDING TO THE REQUIREMENTS SET FORTH BY THE RWQCB AND THE CITY OF UKIAH, AS PROVIDED IN THE RAP AND SUPPLEMENTARY DOCUMENTS ISSUED BY THESE AGENCIES.

A DAILY OPERATION LOG SHALL BE MAINTAINED AT THE SITE TO RECORD THESE ROUTINE INSPECTIONS. THE LOG SHALL BE A BOUND, HARD-COVERED BOOK WITH NUMBERED PAGES. IN ADDITION TO FLOW TOTALIZER READINGS AND OTHER OBSERVATIONS, THE OPERATOR(S) SHALL RECORD ANY PROBLEMS ENCOUNTERED, THE CORRECTIVE ACTIONS TAKEN, AND ANY OTHER RELEVANT INFORMATION. EACH ENTRY SHALL INCLUDE THE TIME, DATE, AND THE OPERATOR'S NAME OR INITIALS. THE INFORMATION IN THE DAILY OPERATION LOG WILL BE USED IN PREPARING MONTHLY REPORTS TO TEE RWQCB AND IN EVALUATING THE EFFECTIVENESS OF THE GROUND WATER EXTRACTION AND TREATMENT SYSTEM.

INFORMATION RELATED TO WATER QUALITY SAMPLING SHALL ALSO BE RECORDED IN THE LOG BOOK. THIS INFORMATION SHOULD INCLUDE, AT A MINIMUM:

- SAMPLE LOCATIONS
- DATE AND TIME OF SAMPLE COLLECTION
- NUMBER OF CONTAINERS COLLECTED
- ANALYSES REQUESTED
- NAME OF SAMPLING PERSONNEL
- COMMENTS.

COMMENTS MAY INCLUDE SUCH THINGS AS ODORS OBSERVED, APPEARANCE OF THE WATER (TURBIDITY, COLOR, ETC.), WEATHER CONDITIONS, OR OTHER PERTINENT INFORMATION.

10.4 GENERAL SAFETY PROCEDURES

THE GENERAL SAFETY PROCEDURES PERTINENT TO THE RECOMMENDED REMEDIAL ACTION ARE AS FOLLOWS:

- OPERATING EQUIPMENT SHALL BE CHECKED FREQUENTLY FOR SIGNS OF LEAKAGE, CORROSION, OR DAMAGE. ANY SUCH DEFECTS NOTED SHALL BE REPAIRED OR OTHERWISE CORRECTED BEFORE ANY ADVERSE CONSEQUENCES RESULT.

- TOOLS, PIPE, AND OTHER EQUIPMENT SHALL NOT BE LEFT LYING AROUND THE EXTRACTION WELL HEADS OR AROUND THE ELECTROCHEMICAL TREATMENT UNIT.

- WASTE MATERIAL AND SLUDGE SHOULD BE PLACED IN A SUITABLE RECEPTACLE OR REMOVED FROM THE SITE ACCORDING TO THE APPROPRIATE REGULATIONS.

- ANY SPILLS OF CONTAMINATED GROUND WATER SHALL BE CLEANED UP IMMEDIATELY AND REPORTED, AS APPROPRIATE.

IT IS RECOMMENDED THAT ONLY PERSONS FAMILIAR WITH THE GROUND WATER EXTRACTION AND TREATMENT SYSTEM PERFORM OPERATION AND MAINTENANCE ACTIVITIES.

10.5 EVALUATION OF SYSTEM EFFECTIVENESS

BASED ON GROUND WATER MONITORING DATA, THE EFFECTIVENESS OF THE EXTRACTION/TREATMENT SYSTEM SHALL BE EVALUATED. THE EVALUATION WILL INCLUDE THE HYDRAULIC RESPONSE OF THE WATER-BEARING ZONES TO EXTRACTION AND WATER QUALITY CHANGES WITH TIME. THIS TYPE OF EVALUATION IS USUALLY PERFORMED ON AN ANNUAL BASIS. THE RESULTS OF SUCH EVALUATIONS WILL BE USED TO MAKE PROJECTIONS FOR AQUIFER CLEANUP AND MODIFICATIONS TO THE REMEDIATION STRATEGY, IF NECESSARY.

10.6 SITE INSPECTION

THE SITE SHALL BE INSPECTED PERIODICALLY TO IDENTIFY POTENTIAL MIGRATION PATHWAYS OF THE CONTAMINANTS AND TAKE APPROPRIATE CORRECTIVE ACTIONS. THE ASPHALT COVER, PARTICULARLY IN RETORT AND SUMP AREAS, SHALL BE CAREFULLY INSPECTED AND REPAIRED ACCORDINGLY TO PREVENT SURFACE INFILTRATION. OTHER SURFACE FEATURES SHALL BE INSPECTED TO PREVENT MIGRATION OF WOOD PRESERVING CHEMICALS INTO SURFACE WATERS.

10.7 REPORTING

THE REPORTING REQUIREMENTS DURING THE IMPLEMENTATION OF THE RECOMMENDED REMEDIAL ACTION WILL BE IN ACCORDANCE WITH THE GUIDELINES AND PROCEDURES SET FORTH BY THE RWQCB, DHS, EPA, THE CITY, AND OTHER REGULATORY AGENCIES. MONTHLY PROGRESS REPORTS SHALL BE PREPARED AND SUBMITTED TO THE AGENCIES. THE PROGRESS REPORTS WILL PRESENT A SUMMARY OF THE WORK PERFORMED, DATA COLLECTED, AND INTERPRETATIONS MADE IN THE PRECEDING MONTH. IF CHANGES NEED TO BE MADE, THE PROGRESS REPORTS WILL OUTLINE THE PROPOSED CHANGES FOR THE AGENCIES' INFORMATION AND APPROVAL. AN ANNUAL REPORT ALL BE PREPARED SUMMARIZING THE DATA OBTAINED AND THE ASSOCIATED FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS.

#TA

TABLE 10

WATER QUALITY CRITERIA SUMMARY

NOTE: THIS CHART IS FOR GENERAL INFORMATION; PLEASE USE CRITERIA DOCUMENTS OR DETAILED SUMMARIES IN "QUALITY CRITERIA FOR WATER 1986" FOR REGULATORY PURPOSES.

CONCENTRATIONS IN UG/L

COMPOUND	PRIORITY POLLUTANT	EPA CARCINOGENICITY CLASSIFICATION (4)
ARSENIC	Y	A
ARSENIC (PENT)	Y	A
ARSENIC (TRI)	Y	A
CHROMIUM (HEX)	Y	A
CHROMIUM (TRI)	N	A
COPPER	Y	D

COMPOUND	FRESH ACUTE CRITERIA	FRESH CHRONIC CRITERIA
ARSENIC		
ARSENIC (PENT)	850(2)	48(2)
ARSENIC (TRI)	360	190
CHROMIUM (HEX)	18	11
CHROMIUM (TRI)	1,700(3)	210(3)
COPPER	18(3)	12(3)

COMPOUND	MARINE ACUTE CRITERIA	MARINE CHRONIC CRITERIA
ARSENIC		
ARSENIC (PENT)	2,319(2)	13(2)
ARSENIC (TRI)	69	36
CHROMIUM (HEX)	1,100	50
CHROMIUM (TRI)	10,300(2)	
COPPER	2.9	2.9

TABLE 10 (CONT)

UNITS PER LITER

COMPOUND	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY
ARSENIC	2.2 NG(1)	17.5 NG (1)
ARSENIC (PENT)		
ARSENIC (TRI)		
CHROMIUM (HEX)	50 UG	
CHROMIUM (TRI)	170 MG	3,433 MG
COPPER		

COMPOUND	DRINKING WATER M.C.L
ARSENIC	0.05 MG
ARSENIC (PENT)	
ARSENIC (TRI)	
CHROMIUM (HEX)	0.05 MG
CHROMIUM (TRI)	0.05 MG
COPPER	

COMPOUND	DATE REFERENCE	NO. OF STATES WITH AQUATIC LIFE STANDARD
ARSENIC	1980FR	21
ARSENIC (PENT)	1985FR	21
ARSENIC (TRI)	1985FR	21
CHROMIUM (HEX)	1985FR	24
CHROMIUM (TRI)	1985FR	24
COPPER	1985FR	2

NOTES: 1) INSUFFICIENT DATA TO DEVELOP CRITERIA. VALUE PRESENTED IS THE LOWEST OBSERVED EFFECT LEVEL (LOEL).

2) HUMAN HEALTH CRITERIA FOR CARCINOGENS REPORTED FOR THREE RISK LEVELS. VALUE PRESENTED IN THE (10-6) RISK LEVEL.

3) HARDNESS DEPENDENT CRITERIA (100 MG/L USED)

4) GROUP A DENOTES "HUMAN CARCINOGEN" AND GROUP D DENOTES " NOT CLASSIFIABLE."

REFERENCE: US ENVIRONMENTAL PROTECTION AGENCY, MAY 1, 1987, "QUALITY CRITERIA FOR WATER 1986," UPDATE #32, OFFICE OF WATER REGULATIONS AND STANDARDS, CRITERIA AND STANDARDS DIVISION.

TABLE 11

PUBLIC HEALTH PROTECTION STANDARDS

MEDIUM	CHEMICAL SPECIES/FORM	RECOMMENDED OR ESTABLISHED STANDARD	REFERENCE
DRINKING WATER	CR(VI)	0.05 MG/L	US PUBLIC HEALTH STANDARDS, 1962
DRINKING WATER	TOTAL CR	0.05 MG/L	NAS, 1974; US EPA, 1976
WORKPLACE AIR	CARCINOGENIC FORMS	0.001 MG/M(3)	NIOSH, 1975
WORKPLACE	NONCARCINOGENIC	0.025 MG/M(3)	TWA ORNIOSH, 1975
AIR	FORMS OF CR(VI)	0.05 MG/M(3)	CEILING
AMBIENT WATER	CR(VI)	0.05 MG/L	US EPA, 1980
AMBIENT WATER	CR(III)	0.170 MG/L	US EPA, 1980
AMBIENT AIR (?)	(?)	0.15 UG/M(3)	CARB RISK VALUE

TABLE 12

ESTIMATED COST OF VARIOUS REMEDIAL ACTION ALTERNATIVES (ALL AMOUNTS ARE IN THOUSANDS OF DOLLARS)

	SOIL REMOVAL AND OFF-SITE DISPOSAL (4 MONTHS)	SOIL REMOVAL AND ON-SITE TREATMENT (1 YEAR)	IN-SITU TREATMENT (2 YEARS)
DESIGN/CONTROL	10	NA (1)	NA (1)
MOBILIZATION	5	10 - 15	5
EXCAVATION	40 - 50	40 - 50	30 (2)
TRANSPORTATION/ DISPOSAL	1,450	500 (3)	260
HEALTH AND SAFETY	10	30	30
SUPERVISION	20	150	100
SITE RESTORATION	10	30	30
CONTRACTOR PROFIT	30 - 70	50 - 80	50 - 75
LABORATORY COSTS	30 - 50	50 - 80	50 - 75
REPORTING	30 - 40	70	70
TOTAL COSTS (5)	1,635 - 1,715	930 - 1,005 (6)	625 - 675 (7)

NOTES:
(1) NA DENOTES NOT AVAILABLE; COST DEPENDS ON DESIGN REQUIREMENTS.
(2) ASPHALT REMOVAL.
(3) TREATMENT ONLY.
(5) ALL COSTS ARE ESTIMATES AND ARE INTENDED TO PROVIDE RELATIVE COST COMPARISONS FOR REMEDIATION ALTERNATIVES. INFLATION FACTOR IS NOT CONSIDERED.
(6) EXCLUDING DESIGN COSTS.
(7) EXCLUDING DESIGN AND FIELD TESTING COSTS.

	PARTIAL EXCAVATION OFF-SITE DISPOSAL (4 MONTHS)	CONTAINMENT (2 YEARS)	NO ACTION (2 YEARS)
DESIGN/CONTROL	5	20	5
MOBILIZATION	5	5	0
EXCAVATION	15 - 25	0	0
TRANSPORTATION/ DISPOSAL	200 - 275	0	0
HEALTH AND SAFETY	10	10	0
SUPERVISION	10	15 - 20	0
SITE RESTORATION	10	0	0
CONTRACTOR PROFIT	20 - 40	25 (4)	0
LABORATORY COSTS	15 - 25	12 - 15	15
REPORTING	10 - 15	12 - 15	15
TOTAL COSTS (5)	300 - 420	99 - 110	35

NOTES: (4) WELL DEVELOPERS, SAMPLERS.
(5) ALL COSTS ARE ESTIMATES AND ARE INTENDED TO PROVIDE RELATIVE COST COMPARISONS FOR REMEDIATION ALTERNATIVES. INFLATION FACTOR IS NOT CONSIDERED.

APPENDIX E

RAP, RAP Amendment and ESD

COAST WOOD
Preserving, INC.

- Final Remedial
Action Plan

September 1989

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF HEALTH SERVICES
TOXIC SUBSTANCES CONTROL PROGRAM
?151 BERKELEY WAY, ANNEX 7
BERKELEY, CA 94704

September 29, 1989

This Final Draft Remedial Action Plan (RAP) has been circulated for public comment from May 9 to June 8, 1989. In addition, a public meeting was held on May 25, 1989.

There were no written or oral public comments on the Draft RAP. The Department has not reached agreement with Coast Wood Preserving Inc., and has made minor revisions to the RAP as deemed appropriate. The document is stamped draft, however, the Department is issuing it as the final.

Therefore, the Department has approved the Final Draft Remedial Action Plan, and the Final Draft RAP will serve as the Final RAP.

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF HEALTH SERVICES
TOXIC SUBSTANCES CONTROL PROGRAM
2151 BERKELEY WAY, ANNEX 7
BERKELEY, CA 94704

September 29, 1989

CERTIFIED MAIL

Mr. Harold Logsdon, President
Coast Wood Preserving, Inc.
600 W. Glenwood
Turlock, CA 95380

Dear Mr. Logsdon:

COAST WOOD PRESERVING - FINAL REMEDIAL ACTION PLAN

This letter is to notify you that the Department of Health Services (Department) has approved the Final Remedial Action Plan (RAP) for Coast Wood Preserving, Inc. The Department has made minor revisions to the Draft RAP as deemed appropriate, and has determined that the Final RAP satisfactorily addresses all applicable state and federal statues and regulations.

Enclosed is a copy of the Final RAP. Note that Sections 2.7 and 7.2 require that the Final Deed Restriction be recorded with Mendocino County within 30 days after Departmental approval of the Final RAP.

Also, pursuant to Remedial Action Order Docket Number 88/89-015, Coast Wood Preserving Inc. is required to comply with the following Sections:

1. Section 5.4.- Within 30 days after Departmental approval of the Final RAP, Coast Wood Preserving shall submit to the Department for review and approval a detailed engineering design of the approved remedial action alternative and a schedule for implementing the construction phase. Specifically, all groundwater plume control measures must be implemented and a schedule of all ongoing operations must be included.

2. Section 5.10.- Coast Wood Preserving shall provide financial assurance within 30 days of Department approval of the Final RAP.

In addition, you have the option to seek judicial review of the Final RAP (within 30 days of the date of this letter). Based upon the percentage of financial responsibility assigned, you may also be eligible to dispute the preliminary allociation of financial

responsibility, as specified in the Final RAP, by convening an arbitration proceeding (within 15 days of the date of this letter) and agreeing to binding arbitration by the arbitration panel. To exercise the arbitration option, it is necessary that the party or parties making the request be assigned a minimum of 51% of the responsibility for the site. Filing for judicial review of requesting arbitration will not stay implementation for the cleanup actions specified in the Final RAP.

Sincerely,

Howard K. Hatayama
Regional Administrator
Region 2
Toxic Substances Control Program

Enclosures

Cert. Mail. #P 915 746 228

cc: Gene Pietila, Coast Wood Preserving, Inc.
Robert Borenstein, US EPA
Susan Warner, North Coast RWQCB
Gerald Davis, Mendocino County Environmental Health Dept.

HH:mr

Project No. 86-113
May 1989

Final Draft

REMEDIAL ACTION PLAN

Coast Wood Preserving, Inc.
Ukiah, California

GEOSYSTEM
CONSULTANTS, INC

May 3, 1989

Project No. 86-113

5-059
MAY 04 1989
MR

Mr. Eugene Pietila
Manager
FONTANA WOOD PRESERVING, INC.
1550 Valencia Avenue
Fontana, California 92335

Final Draft
Remedial Action Plan
Coast Wood Preserving, Inc.
Ukiah, California

Dear Mr. Pietila:

Transmitted herewith are two copies of the final draft of the Remedial Action Plan (RAP) for the Coast Wood Preserving, Inc. facility in Ukiah, California. Appropriate number of copies of this final draft have been forwarded to the regulatory agencies. We appreciate the opportunity of providing services to Coast Wood Preserving, Inc. If you have any questions, please do not hesitate to call.

Sincerely,

GEOSYSTEM CONSULTANTS, INC.

Mohsen Mehran

Mohsen Mehran, Ph.D.
Project Manager

MM:go
Enclosures

cc: Mr. Dwight Hoenig-DHS
Ms. Michelle Rembaum-DHS
Ms. Susan Warner-RWQCB, North Coast Region
Mr. James Hanson-U.S. EPA
Mr. Gerald Davis-Mendocino County Department of Environmental Health

18218 McDurmott East Suite G • Irvine, California 92714
Telephone (714) 553-8757 • FAX (714) 261-8550

Final Draft

REMEDIAL ACTION PLAN
COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

Prepared for

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

DRAFT

Prepared by

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Project No. 86-113

May 1989

GEOSYSTEM

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ACKNOWLEDGEMENTS

Several people have made invaluable contributions during the site characterization studies and the preparation of this Remedial Action Plan. Mr. Eugene Pietila and Mr. Harold Logsdon of Coast Wood Preserving, Inc. provided support, guidance, and assistance throughout the project. Ms. Susan Warner and Ms. Bonnie Rolandelli of the California Regional Water Quality Control Board, North Coast Region; Mr. Jerry Marcotte, Mr. Howard Hatayama, Mr. Dwight Hoenig, Mr. Ted Park, Ms. Michelle Rembaum, and Mr. Richard Jones of the Department of Health Services; Mr. James Hanson and Mr. Marvin Young of the U.S. Environmental Protection Agency; Ms. Mary Hackenbracht of the State of California Department of Justice; Mr. Robert Pedroncholi of the City of Ukiah; Ms. Betty Swatsenberg of the State Department of Water Resources; and Mr. Dave Redding of the Willow County Water District, all provided information essential to the completion of this work. The contributions of all these individuals are gratefully acknowledged.

DRAFT

1.0 INTRODUCTION

Since June 1980, a number of studies have been conducted to investigate the presence of chromium, copper, and arsenic in the subsurface environment at the Coast Wood Preserving, Inc. (CWP) facility (the site) in Ukiah, California. The investigations were designed to characterize surface and subsurface conditions and delineate the areal and vertical extent of chromium, copper, and arsenic in soil and ground water at the site. Concurrent with the investigations, a number of interim remedial measures have been implemented to contain the chromium plume in ground water and remediate subsurface conditions.

The state and federal agencies responsible for overseeing the CWP investigations include the California Regional Water Quality Control Board, North Coast Region (RWQCB), Department of Health Services (DHS), and U.S. Environmental Protection Agency (EPA). Throughout this report, the RWQCB, DHS, and EPA are referred to collectively as "the regulatory agencies."

In compliance with Section 25356.1 of the California Health and Safety Code (1986), the regulatory agencies have requested CWP to submit a Remedial Action Plan (RAP) to address soil and ground water contamination which may have originated from CWP's operation. On behalf of CWP and in response to this request, Geosystem Consultants, Inc. (Geosystem) submitted a predraft RAP (Geosystem, September 15, 1986) to the regulatory agencies for review. Subsequent to the submittal of the predraft RAP, a number of additional investigations were performed at the site. Also, in February 1987, DHS issued a draft guidance document for RAP preparation. The draft guidance document provided the format, content, and procedures for preparation, approval, and implementation of the RAP.

Utilizing the results of additional investigations and considering the regulatory agencies review comments, a draft RAP was prepared by Geosystem in accordance with the February 1987 draft RAP guidelines. The draft RAP was submitted for review in July 1987. In September 1987, DHS issued a detailed outline for the preparation of RAPs entitled "DHS, Policy and Procedure for Remedial Action Plan Development and Approved Processes" (DHS, September 1987). Also, in September 1987, the regulatory agencies provided review comments on the draft RAP submitted in July 1987. The agencies comments and the content and format of the most recent RAP guidelines (DHS, September 1987) were considered in the preparation of the Draft No. 2 of the RAP which was issued in February 1988 (Geosystem, February 29, 1988). Subsequently, on August 4, 1988, agencies comments on Draft No. 2 of the RAP were received. Also, on December 16, 1988, DHS issued a Remedial Action Order providing the framework for future site activities including the preparation of this third draft of the RAP. On February 3, 1989, Geosystem issued the third draft of the RAP for agencies review. Agencies comments have been considered in the preparation of this preliminary final RAP.

It is noted that the RAP guidelines prepared by the DHS are consistent with Section 25350, Subpart F of the National Oil and Hazardous Substances Pollution Contingency Plan (U.S. EPA, July 1985), Section 25356.1 of the California Health and Safety Code (1986), and the California Site Mitigation Decision Tree (DHS, June 1985).

1.1 OBJECTIVE

According to the September 1987 DHS guidelines for RAP preparation, "the purpose of a RAP is to compile and summarize site data gathered from the remedial investigation (RI) and the feasibility study (FS), in order to identify, and subsequently design, plan and

implement a final remedial action for a hazardous substance release site." The specific objective of this RAP is to present the findings of the investigations performed at the CWP site, the rationale for selection or rejection of the remedial alternatives considered, and the timeframe for remedial action implementation. The RAP is intended to provide an opportunity for the public and other interested parties to participate in the remedial action decision-making process. According to the DHS, if the remedial action plan is fully implemented and completed, "the site will be certified and transferred to a list of sites which require long term operation and maintenance."

1.2 SITE IDENTIFICATION

The site is known as the Coast Wood Preserving, Inc. (CWP) facility and is located 3 miles south of Ukiah, California, at the intersection of Highway 101 and Taylor Drive. The site location is shown in Figure 1. CWP has conducted wood preserving operations at the site since 1971 and the facility is currently active. Additional details of CWP's wood preserving operation are presented in Section 3.2.1.

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1.3 SCOPE AND REPORT ORGANIZATION

The draft RAP includes relevant background information, a summary and interpretation of the hydrogeologic data, a summary of soil and ground water quality data; a description of the interim remedial measures implemented; a risk assessment; and an evaluation of remedial action alternatives. In addition, the rationale for selection of the proposed remedial actions and rejection of the others is presented.

The format and organization of this document are consistent with the RAP guidelines (DHS, September 1987). An Executive Summary, including a brief description of significant findings, conclusions,

and recommendations, is provided in Section 2.0. Section 3.0 presents a site description, including the history of wood preserving operations and the physical characteristics of the site. Section 4.0 contains a summary of the geologic, hydrologic, and chemical characteristics of soil, surface water, and ground water at the site and immediate vicinity based on the remedial investigations performed. Section 5.0 describes the interim remedial measures implemented during the course of the investigations at the site. Section 6.0 summarizes potential migration pathways and chromium toxicity, and evaluates the possible exposure of the contaminants to potential receptors.

Section 7.0 presents the remedial action alternatives considered to address soil and ground water contamination, including alternative methods of ground water treatment and discharge. In addition, the recommended remedial action to address soil and ground water contamination is presented in Section 7.0. The rationale for the selection of the proposed remedial plan and the applicable regulations are also presented in this section.

The schedule for implementation of the RAP is presented in Section 8.0. The allocation of financial responsibility and operation and maintenance requirements are presented in Sections 9.0 and 10.0, respectively.

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2.0 EXECUTIVE SUMMARY

The draft Remedial Action Plan (RAP) presents the rationale, approach, and framework for the proposed remediation program at the Coast Wood Preserving, Inc. (CWP) facility in Ukiah, California.

2.1 APPLICABLE LAWS AND REGULATIONS

The draft RAP has been prepared in accordance with the guidance document entitled "Remedial Action Plan Development and Approval Process," issued by the DHS (September 1987). The draft RAP is also consistent with the following state and federal requirements and guidelines:

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.
- Resource Conservation and Recovery Act (RCRA) of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.
- Safe Drinking Water Act.
- California Code of Regulations, Title 22, Division 4: Environmental Health (Chapter 1, Article 1; Chapter 2, Article 1; Chapter 30), July 1986.
- California Health and Safety Code.
- North Coastal Basin Water Quality Control Plan adopted by the RWQCB.
- All orders, including specifications, provisions, prohibitions, and requirements issued by the RWQCB.
- Court order by the State of California, Office of the Attorney General.

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- National Contingency Plan, pertinent hazardous waste regulations under 40 CFR, Parts 260 to 265; Part 300-68, July 1985.

- Porter-Cologne Water Quality Control Act, 1969.

2.2 BACKGROUND

Since 1980, a number of investigations have been performed to delineate the areal and vertical extent of chromium in soil and ground water at the CWP site and to characterize hydrogeologic conditions. Soil quality investigations have shown that elevated chromium and arsenic concentrations exist in the upper 1 to 2 feet of the soil profile near and around the retort area. Most soil samples analyzed for total chromium and hexavalent chromium have indicated that trivalent chromium compounds are prevalent in the near-surface soils.

Hydrogeologic studies have demonstrated that the site is underlain by four hydrostratigraphic zones. The upper zone (Zone 1) consists of silty clay and clayey silt, with more permeable stringers and lenses of sand and gravel, to a depth of about 20 feet. This zone is separated from a more permeable sand and gravel layer (Zone 2) by a blue clay. Zone 3 is a clayey silt stratum (Zone 3), and Zone 4 consists of clayey sand and gravel. Zone 1 is the primary zone of concern because of the presence of chromium in ground water. The depth to ground water varies from 5 to 10 feet and ground water generally flows to the southeast.

Ground water quality data show that chromium concentrations are higher near the retort area, and decrease in the downgradient direction. In the last three years, most off-site wells have not exhibited chromium concentrations in excess of the drinking water

standard (0.05 mg/l). Most storm water quality monitoring data indicate that chromium concentrations are generally near or below detection limits.

Geochemical tests have been performed to evaluate the sorption and desorption characteristics of chromium and arsenic in soil and ground water. Sorption tests have shown that Zone 1 material is capable of adsorbing hexavalent chromium to the extent that chromium migration is at least 5 times slower than ground water flow. Desorption tests have indicated that a reduction in chromium concentration can be achieved by ground water extraction. The geochemical data have been used to estimate the time of aquifer cleanup. Absence of dissolved arsenic in ground water monitoring wells indicates high adsorption capacity for arsenic compounds.

Potential migration pathways through air, direct exposure to soil, surface water, and ground water have been assessed. It is concluded that the most probable migration pathway is via ground water flow. Because of the overall site improvements and the interim remedial measures implemented, however, off-site migration is unlikely. A transport model has been utilized to assess the areal distribution of chromium in case of off-site migration. Considering the low population density downgradient of the facility and the absence of water-producing wells in the immediate site vicinity, there is no present potential exposure through ground water. Therefore, there is no health risk associated with this pathway if off-site migration is prevented.

2.3 INTERIM REMEDIAL MEASURES

Since the initiation of investigations at the CWP site, a number of remedial measures have been implemented by CWP. General facility improvements have included grading and construction of berms to prevent surface runoff from the retort and treated wood

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storage areas, surface paving, and construction of roofs over the retort area. These improvements have substantially reduced the potential for soil, storm water, and ground water contamination.

In October 1983, without regulatory agency approval and/or oversight, CWP constructed a 300-foot long, slurry cutoff wall along the eastern site boundary to a depth of about 20 feet. Chromium-containing ground water is pumped from an extraction trench located hydraulically upgradient of the slurry wall. The trench appears to be capable of intercepting and hydraulically controlling ground water in Zone 1. Extracted water is recycled back into CWP operations when possible. The presence of the slurry cutoff wall and extraction from the trench have been effective in reducing the off-site migration of chromium.

2.4 REMEDIAL ACTION ALTERNATIVES

A feasibility study has been conducted to screen and evaluate viable remedial action alternatives. In conducting the feasibility study, contaminated soil was considered the primary potential source of ground water contamination. Contaminated ground water was considered the principal potential hazard to human health and the environment. In evaluating the alternatives, soil and ground water elements were addressed separately.

Remediation of contaminated soils will occur at the time of closure of the facility, projected to be 10 years. A trust fund will be established (Section 9.0) to fund future remediation of soils. The potential remedial options considered for control of the contaminated soil included soil removal/off-site disposal, soil removal/on-site treatment, containment, in-situ treatment, and no action. Treatability studies will be conducted prior to selecting the final soils remedy at the time of closure of the facility. It

is anticipated that on-site soil treatment options will increase as this technology develops over the next 5 to 10 years.

The alternatives considered for control of the chromium plume included physical containment, in-situ treatment, hydraulic control, and no action. Based on proven technological considerations and cost, hydraulic control was selected as the most cost-effective remedial measure. This option was evaluated for plume control near the retort area, near the site boundary, and off site.

As hydraulic control requires proper handling of contaminated ground water, various discharge options were considered. The most cost-effective options include recycling the ground water into CWP operations or discharge of treated water into the sanitary sewer. Viable ground water treatment options include electrochemical processes, chemical reduction/precipitation, activated carbon adsorption, ion exchange, reverse osmosis, and electrodialysis. Based on availability, proven technological considerations, and cost-effectiveness, the electrochemical process was selected for ground water treatment.

2.5 <u>SELECTED REMEDIAL ACTION ALTERNATIVE</u>

The selected remedial action alternative included the following elements:

- o Surface runoff management.
- o Control and remediation of contaminated soil.
- o Plume control and aquifer remediation.
- o Electrochemical treatment of ground water.
- o Water recycling/discharge to Ukiah Sewage Treatment Plant or reinjection.
- o Monitoring.

Surface runoff will be controlled to prevent potentially contaminated water entering surface water drainage features. The site will be inspected periodically and surface paving repaired as appropriate. Storm water monitoring shall be performed and the data evaluated according to RWQCB Order No. 85-101.

Contaminated soils will be controlled by preventing surface water infiltration and by exercising hydraulic control of the plume. Surface paving will prevent the surface soils from acting as a source of ground water contamination. Chromium leached from the soil as a result of ground water level fluctuations will be controlled hydraulically in the retort area and near the site boundary. Hydraulic containment will be achieved by a ground water extraction and treatment system utilizing the existing extraction Wells HL-7 and CWP-18. These provisions will prevent direct human exposure to contaminated soil, eliminate the contribution of infiltrating surface water to ground water contamination, and prevent off-site migration. After site closure, the contaminated soils will be remediated by on-site treatment as discussed in the previous section.

Plume control and aquifer remediation will be performed by ground water extraction near the retort area and at the site boundary. Well CWP-18, located in the retort area, will be pumped to extract ground water containing elevated chromium concentrations. Although the yield of this well is small and continuous pumping may not be possible, the potential impact on aquifer restoration is believed to be significant.

At the site boundary, Well HL-7 (installed in the extraction trench) will be pumped at flow rates ranging from 5 to 20 gpm. Extraction from the trench will produce a zone of influence which

will contain the chromium plume, prevent off-site migration, and gradually restore the aquifer. Considering the total estimated volume of contaminated fluid, pore volume reduction requirements, and expected flow rates, the projected minimum duration of aquifer cleanup is about seven years. However, considering the nature of the assumptions and uncertainties associated with this estimated time of aquifer cleanup, a conservative duration of 20 years is projected for project management and budgetary purposes. Provision is also made to extract water from Well CWP-8, located on the downgradient side of the slurry cutoff wall. Extraction from this well will contain any residual chromium that may pass the barrier. Containment of chromium in this location will prevent contamination of downgradient areas.

A contingency plan has also been developed for the extraction of ground water in the off-site area located near monitoring Well AT-2. Depending on future concentrations detected in the off-site wells, additional extraction wells may be necessary to insure hydraulic control of the contaminated plume.

The extracted water will be recycled into CWP operations, to the extent possible, or treated electrochemically and discharged into the sanitary sewer. Implementation of this discharge option will provide maximum flexibility in selecting extraction rates from Well HL-7, and will increase the effectiveness of cleanup operations. The treatment system effluent concentrations will meet the requirements of the Ukiah Sewage Treatment Plant.

Air, storm water, and ground water quality monitoring shall be performed according to general and site-specific protocols. Storm water monitoring shall be performed at the locations and frequencies specified by RWQCB Order No. 85-101. Storm water samples will be analyzed for dissolved total chromium and arsenic.

Ground water shall be monitored in on-site and off-site wells installed specifically for the CWP project. Ground water monitoring includes water level measurements and water quality analyses. The ground water samples shall be analyzed for dissolved total chromium, as specified in RWQCB Revised Monitoring and Reporting Program No. 85-101, issued in May 1987, and any subsequent order, as appropriate. Monitoring locations and frequencies are subject to change as remediation proceeds.

Monitoring shall be performed according to the procedures outlined in the "Ground Water/Storm Water Monitoring Protocol" dated August 1987, prepared specifically for the CWP facility. The monitoring data shall be reviewed periodically to evaluate the effectiveness of the RAP, and recommendations and modifications shall be made as appropriate. The monitoring data and results of these evaluations shall be reported to the RWQCB as required by the Revised Monitoring and Reporting Program No. 85-101.

2.6 ALLOCATION OF FINANCIAL RESPONSIBILITY

CWP has owned and operated the Ukiah facility since 1971 and will be responsible for implementation of the RAP. The provisions for financial assurance are provided in Section 9.0 of this report.

2.7 DEED RESTRICTION ON REAL PROPERTY

Within 30 days after Department approval of the Final (draft) RAP Coast Wood Preserving Inc., must record the final Deed Restriction with Mendocino County.

3.0 SITE DESCRIPTION

This section provides a summary of background information pertinent to the RAP, including the location, history, and a physical description of the site. The content and format of this section are generally consistent with the RAP guidelines provided by the DHS (September 1987).

3.1 SITE LOCATION

The CWP facility is located at the intersection of Plant Road and Taylor Drive in an unincorporated area of Mendocino County, about 3 miles south of Ukiah, California. The site location is shown in Figure 1. The site covers an area of approximately 8 acres and is located in Section 22 of Township 15 North, Range 12 West, relative to the Mount Diablo baseline and meridian. For the purpose of this draft RAP, the "site" refers to the area bounded by U.S. Highway 101 to the west, Plant Road to the north, Taylor Drive to the east, and an unpaved track to the south. The "study area" refers to the area bounded by Plant Road and the Ukiah Sewage Disposal facility to the north, the Russian River to the east, Robinson Creek to the south, and U.S. Highway 101 to the west. The study area is delineated in Figure 1. The site and vicinity is shown in Figure 2.

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3.2 SITE HISTORY

This section includes a brief description of wood preserving operations at the site; the type of chemicals handled; and a chronology of site contamination, investigation, and interim remedial measures.

3.2.1 Wood Preserving Operations

CWP began wood preserving at the site in 1971 and the facility has operated continuously up to the present date. It is believed that

prior to 1971, the land was used for agricultural purposes. The wood preserving operations and facilities have been periodically upgraded since 1971 by implementing surface runoff control measures, surface paving, construction of canopies over wood treatment areas, and the development of treated wood storage and handling procedures.

The wood preserving operation at the site involves the use of a chemical mix consisting of 65.5 percent sodium dichromate, 18.1 percent copper sulfate, and 16.4 percent arsenic acid. A dilute solution of the chemical mix, containing the equivalent of 1.5 percent by weight of CrO_3, CuO, and As_2O_5, is used to bathe the lumber in pressurized retort chambers. After each treatment the retort chambers are drained and the preserving solution is recycled into the working solution tank. Residual solution draining from the retort chambers and drippings from the freshly treated wood are collected in concrete-lined sumps and are also recycled into the chemical mix tank via temporary holding tanks. The solution transfer takes place through above-ground PVC pipes. A plan of the site, including the facilities mentioned above, is shown in Figure 2.

3.2.2 Chemical Releases

Concerns regarding the possible release of wood preserving chemicals from the CWP site were raised by the County of Mendocino, the Department of Fish and Game, and the RWQCB in early 1972. A chronology of the subsequent interaction between the regulatory agencies and CWP is presented in Appendix A. The cumulative drippings from treated wood over the years are believed to have resulted in near-surface soil contamination at the site, particularly during the early years of operation when the treatment and treated wood storage areas were not all paved. Currently, all

but the south and southeast portion of the site (as shown in Figure 2) is paved with asphalt or concrete.

3.2.3 Previous Studies

As indicated in Section 3.2.2, the RWQCB first became involved in the environmental aspects of CWP's wood preserving operations in early 1972. The RWQCB's specific concerns were related to potential surface water and ground water contamination. Appendix A provides a chronology of events related to environmental activities at the site.

On June 13, 1980, RWQCB staff collected samples of surface water runoff which were found to contain wood preserving chemicals. In September 1980, the RWQCB requested that CWP assess and report the possible impact of wood preserving operations on soil and ground water quality beneath the site. This assessment, performed by H. Esmaili & Associates, Inc. (August 1981) and referred to as the Phase I study, included the installation of six shallow ground water monitoring wells (Wells CWP-1 through CWP-6). The locations of these monitoring wells are shown in Figure 2 and the construction details are summarized in Table 1. The investigation indicated elevated chromium concentrations in near-surface soil samples and ground water samples collected from Wells CWP-1 through CWP-6. No abnormal concentrations of arsenic or copper were found in any of the ground water samples.

In October 1981, CWP installed Wells CWP-7, CWP-8, and CWP-9 along the eastern site boundary to evaluate possible off-site migration. In December 1981, the RWQCB installed off-site monitoring Wells FPT-1A, FPT-1B, FPT-2A, and FPT-3 to the east of the site. The analysis of ground water samples from these wells confirmed that off-site migration of chromium had occurred.

See supplemental pages 3-3 & 3-4 for this paragraph

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In October 1983, acting on its own initiative but without regulatory agency approval or oversight, CWP constructed a bentonite slurry cutoff wall, near the eastern site boundary, to intercept and limit the migration of chromium in ground water. CWP also constructed a ground water extraction trench immediately to the west and hydraulically upgradient of the slurry cutoff wall. The approximate locations of the slurry cutoff wall and the extraction trench are shown in Figure 2. As an interim remedial measure, CWP began extracting ground water from the trench via a central sump, known as Well HL-7, equipped with an electric, submersible pump. The extracted ground water was recycled back into the wood preserving operation. Also, as part of the overall effort to improve site conditions, CWP erected canopies over the retort area. These covers limit the exposure of freshly treated wood to precipitation and reduce surface water runoff from this area. These interim remedial measures are described in more detail in Section 5.0.

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Additional studies were subsequently initiated to determine the extent of ground water contamination and evaluate the feasibility

of containing contaminated ground water on site. This Phase II study, conducted by J. H. Kleinfelder & Associates (November 1982), included the installation of seven additional on-site ground water monitoring wells (CWP-10 through CWP-16) and showed that the vertical extent of chromium, copper, and arsenic in soil and ground water was limited. The locations of the ground water monitoring wells installed during the Phase I and Phase II studies are shown in Figure 2. Additional off-site ground water monitoring wells (Wells AT-1, AT-2, AT-3, FPT-4, and FPT-5) were subsequently installed by Kleinfelder and CWP to further delineate off-site contamination.

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After reviewing the findings of Phases I and II of the investigation, the regulatory agencies requested that CWP further define the distribution of chromium, arsenic, and copper in soil

After reviewing the findings of Phases I and II of the investigation, the regulatory agencies requested that CWP further define the distribution of chromium, arsenic, and copper in soil and ground water. D'Appolonia Consulting Engineers, Inc. (D'Appolonia) was retained by CWP to perform this investigation and address the agencies' concerns. The investigation included a series of soil sampling borings, Borings S-1 through S-26 (D'Appolonia/IT Corporation, May 1984)[1], the locations of which are shown in Figure 2. The investigation showed that the top one to two feet of the soil profile around the retort and rail line areas contained elevated concentrations of chromium and arsenic. It is noted, however, that no soil samples were collected from beneath the actual retorts. The ground water quality data indicated elevated concentrations of chromium in monitoring wells located near the retort areas. Chromium concentrations in ground water generally decreased with distance from the retort area in the downgradient direction.

Subsequent to regulatory agency review of the findings of the D'Appolonia investigation, another study was initiated to further define the extent and migration behavior of chromium in ground water and evaluate viable remedial action alternatives to address contaminated soil and ground water. This investigation (IT Corporation, June 1985) led to the following conclusions:

- Containment of contaminated soil and remediation of the contaminated water-bearing zone by hydraulic control measures, such as ground water extraction, was feasible.
- The majority of the extracted ground water could be reused in CWP's wood preserving operations and the excess could be treated cost-effectively by the existing electrochemical unit at the site.

(1) In March 1984, D'Appolonia was acquired by IT Corporation.

Subsequent to this investigation, a large diameter extraction well, Well CWP-18, was installed near the retort area to contain contaminated ground water to the extent possible. Also, an injection well, Well CWP-19, was installed hydraulically upgradient of the retort area and the existing chromium plume so that excess treated water could be injected back into the water-bearing zone. The retort area extraction well and the upgradient injection well are described further in Section 5.0.

In response to concerns expressed by the regulatory agencies regarding the effectiveness of the extraction trench and the slurry cutoff wall in remediating and containing the chromium plume near the eastern site boundary, Geosystem performed a number of investigations to evaluate aquifer parameters, assess the leaching behavior of soils, and estimate the duration of aquifer cleanup (Geosystem, March 1986; November 1986). A number of additional on-site and off-site monitoring wells (Wells CWP-22, AT-4, and AT-5) were also installed to investigate ground water quality hydraulically downgradient of the slurry cutoff wall. The locations of the on-site and off-site ground water monitoring wells are shown in Figure 2, and the well construction details are summarized in Table 1.

In addition to the studies performed by their consultants, CWP conducted regular ground water monitoring using their own resources. The ground water monitoring program was originally specified by the RWQCB in Order No. 83-93, which was adopted in June 1983. Order No. 83-93 has been revised and/or superseded several times as additional monitoring wells have been installed and existing wells abandoned or deleted from the monitoring program. The current monitoring program is in accordance with the requirements of the most recent revision of the RWQCB order (May

1987). Monitoring includes the collection and analyses of storm water samples for chromium and arsenic. The monitoring program also includes ground water level measurement and the collection and analyses of ground water samples for dissolved total chromium. Ground water monitoring is performed according to the Ground Water Monitoring Protocol (Geosystem, August 1987) prepared specifically for the CWP project.

The water level measurement and ground water quality data obtained by CWP, consultants acting on behalf of CWP, and regulatory agency personnel have been compiled by Geosystem on a computer-based data management system. A summary of these data is presented in Appendix B. A summary of the storm water quality data is presented in Appendix C, and a summary of the soil quality analyses performed is presented in Appendix D.

Because of the large volume of previously reported investigations, this summary is intended to provide only a brief introduction to the characterization studies performed at the site. Additional details and interpretation of the findings of these investigations are presented in Section 4.0 and in the subject-specific, technical reports referenced.

3.3 PHYSICAL DESCRIPTION

This section includes descriptions of topography, physical setting, demography, climatology, sensitive structures, and potential receptors.

3.3.1 Topography

The CWP site is located in the Ukiah Valley. In the vicinity of the site, the valley floor is about 2.5 miles wide. The valley tapers to an unnamed, narrow gorge, several hundred feet wide, at a point about 4.5 miles south of the site. The Russian River flows

south through this gorge from the Ukiah Valley into Hopland Valley. The valley floor at the site is at an elevation of about 565 to 585 feet above mean sea level (MSL) and slopes gently to the south, along the axis of the valley, at a gradient of about 0.2 percent (1 in 500).

The Ukiah Valley is bounded by steep mountains to the east and west. Those to the east of the site are known as the Mayacmas Mountains and rise to over 3,600 feet above MSL. The mountains to the west include Cleland Mountain and Elledge Peak which rise to over 2,500 feet above MSL. The slopes of the mountains bounding the Ukiah Valley range from about 12 to 67 percent.

Steep-sided valleys, approximately perpendicular to the axis of the Ukiah Valley, are also prominent topographic features. These valleys typically contain tributaries to the Russian River. The most significant of these with respect to the CWP site is the valley occupied by Robinson Creek, which enters the Ukiah Valley from the west, approximately 4,500 feet south of the CWP site, as shown in Figure 1.

The topography of the CWP site itself has been locally altered by grading for drainage and foundation purposes. In general, however, the land surface slopes gently to the east, towards Taylor Drive.

3.3.2 Site Features

In terms of surface structures, the site features a general office in the northwest corner and a garage or service type structure near the center of the site. The two retorts in which lumber is pressure treated are orientated east-west near the western site boundary. Each retort chamber is approximately 70 feet long. The rail lines associated with each retort extend about 140 feet to the east. The sump to which the retorts drain is located at the

eastern end of the vessels. The wood preserving solution is recycled to, and stored in, four large above-ground tanks along the western site boundary.

Other significant site features include a walled work tank area in which wood preserving solution is mixed. This work tank area includes a large concrete sump containing "make-up" water. Ground water extracted from Wells HL-7 and CWP-18 is discharged to this sump to be recycled in the wood preserving operation. A large, 330,000 gallon, above-ground tank is used to store treated ground water.

The majority of the site is paved with asphalt concrete and is used for wood storage. Treated wood is stored in the northeast corner of the site. Surface runoff from this area is controlled by asphalt berms and collected in a sump on the eastern site boundary, from which it is returned to the make-up water sump. The unpaved areas of the site are located along the southeastern and southern site boundaries and are generally vacant or used for untreated wood storage.

The CWP facility is fenced for security and is accessed via two sliding gates which are locked outside of normal business hours or used for untreated wood storage.

3.3.3 Surrounding Land Use

The large majority of the land surface in Mendocino County is occupied by native vegetation and non-irrigated agriculture. A study performed by the Department of Water Resources (May 1980) projected land use in several ground water basins along the Russian River. In 1974, native vegetation and non-irrigated agriculture occupied over 185,000 acres in the Upper Russian ground water basin, in which the CWP site is located. Urban, irrigated

agriculture, and recreational land use accounted for approximately 3,400, 9,900, and 250 acres, respectively. Projections up to the year 2000 suggest that urban and irrigated agricultural land use will increase at the expense of native vegetation and non-irrigated agriculture. Projected recreational land use remains constant.

The principal land use in Mendocino County is for timber production, which provides two-thirds of the county's agricultural revenues. Pasture and range land occupies 672,000 acres, while fruit production, mostly grapes and pears, accounts for 15,000 acres (County of Mendocino, 1985). Major land uses in the general vicinity of the CWP site include vineyards, fruit and nut trees, forested land, single family residences, and transportation. Land use in the immediate vicinity of the CWP site includes timber-related facilities, sewage treatment, fruit trees (pears), transportation (U.S. Highway 101), business and commercial facilities, and vacant lots. Land use within a 1.5 mile radius of the CWP site is shown in Figure 3.

3.3.4 Population Distribution

In 1986, the population of Mendocino County was 74,267, about 50 percent of which resided in the Ukiah area. The population of the city of Ukiah in 1986 was 13,331 (Greater Ukiah Chamber of Commerce, June 1987). Other, smaller communities in the vicinity of the CWP site include Talmage, located approximately 2 miles to the northeast, and Hopland, located approximately 10 miles south along U.S. Highway 101.

The main population center of Ukiah is approximately 3 miles to the north of the CWP site. In the vicinity of the site, there are very few residences. Aerial photographs taken in April 1984 indicate only five residential structures within a quarter-mile radius of the site boundaries. According to Greater Ukiah Chamber

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of Commerce records (June 1987), there are an average of 2.45 residents per dwelling in the city of Ukiah. Using this statistic, it appears that there are less than 15 people living within a quarter-mile of the CWP site.

Interviews conducted by Geosystem personnel indicate that there are four houses, two duplexes, two bunk houses, and six motel units in the study area within one-half mile of the CWP site. It is noted that the motel units are used to house seasonal workers associated with the Alex Thomas pear packing facility. During the winter months, about 20 people may occupy these residences. In the peak fruit harvesting season, however, this number may increase to about 100.

3.3.5 Climatology

This section characterizes the climate in the vicinity of the CWP site in terms of temperature, precipitation, and wind speed and direction. The data have been obtained from various locations in and around Ukiah; however, it is believed that the variations in climate over the relatively small distances from the CWP site are not significant.

3.3.5.1 Temperature

Ukiah has a relatively mild climate, characterized by dry, hot summers and cool, wet winters. Based on records available from 1877 to 1980, the average air temperature reportedly varies from 46.0 degrees Fahrenheit in January to 73.7 degrees Fahrenheit in July, with an average annual air temperature of 59.2 degrees Fahrenheit. The maximum and minimum temperatures recorded in Ukiah since records have been maintained were 114 and 12 degrees Fahrenheit, respectively (Farrar, July 1986). Mean monthly air temperature data for Ukiah are presented in Table 2.

3.3.5.2 Precipitation

Based on records available from 1877 to 1980, the mean annual precipitation in Ukiah is 36.27 inches. The records indicate, however, that considerable variation in annual precipitation is common in the Ukiah area with variations of up to 30 inches occurring in consecutive years. The maximum and minimum precipitation recorded during the period of record was 60.97 and 13.09 inches, in 1890 and 1924, respectively (Farrar, July 1986). Additional precipitation data, reportedly compiled from U.S. Weather Bureau Reports and Ukiah Fire Department records, indicate that total precipitation was 70.19 inches in the 1982-1983 season (Savings Bank of Mendocino County, 1987).

The majority of the precipitation falls as rain between the beginning of October and the end of April, with more than 50 percent of the annual rainfall occurring in December, January, and February. Mean monthly precipitation data, based on records maintained from 1877 to 1980, are summarized in Table 2. On-site precipitation measurements have also been recorded by CWP personnel since December 1981. These data, summarized in Table 3, indicate that the total annual precipitation has ranged from a low of 17.05 inches in 1985 to a high of 51.34 inches in 1983. These data are consistent with measurements recorded elsewhere in the Ukiah area and illustrate the large variations in annual precipitation mentioned above.

3.3.5.3 Wind

Wind data, recorded from 1950 to 1964 at two locations at the Ukiah Municipal Airport, indicate that the mean annual wind speed was 3.7 to 3.9 miles per hour (mph). Wind speeds are generally higher from April to July and are lowest in November and December. The highest mean monthly wind speed recorded was 6.5 mph in June 1959. The lowest was 0.4 mph in December 1963 (California Energy Commission,

April 1985). The prevailing wind direction is reportedly northwest to west (Greater Ukiah Chamber of Commerce, June 1987). The mean monthly and annual wind speeds for the period of record are summarized in Table 2.

3.3.6 <u>Location of Water Wells</u>

A well inventory was performed to locate water wells in the vicinity of the CWP site and to determine their status. Sources of information included primarily records made available by the DWR (June 1956; October 1986) and Willow County Water District (WCWD). In addition, well logs available at DWR in Sacramento, California were reviewed and the locations of wells in the immediate vicinity of the CWP site verified by field inspection. The well inventory focussed on well locations, well construction details, stratigraphy, and the beneficial uses of the extracted water.

The well inventory indicated the presence of several dozen wells in the vicinity of the site. The locations of these wells are shown in Figure 4. It should be noted that, with the exception of the records maintained by WCWD, the information available on well locations and construction details is often vague and incomplete. Few of the wells have been identified according to the state well-numbering system and the information regarding well locations is typically imprecise and insufficient to locate the wells accurately. Geosystem has attempted to locate wells as accurately as possible, based on the available information, and identify the wells according to the state well-numbering system. The well locations shown in Figure 4 must, however, be considered approximate. The available well construction details and beneficial uses of ground water are summarized in Table 4. It is noted that the nearest water-producing well to the CWP site is Well 14N/12W-4D1 which is located about 1,000 feet to the south.

According to information obtained by Geosystem personnel, this well is capped and not currently active. Well 14N/12W-4E1, however, appears to be the nearest water-producing well. According to the owners of the property, the water is used for domestic and irrigation purposes. This well is located about 1,500 feet to the south of the CWP site.

3.3.7 Potential Biological Receptors

Potential biological receptors of contaminants originating from the CWP site are considered to include native vegetation, fruit trees, aquatic life in the Russian River and its tributaries, and wild animals and birds.

Vegetation types found in the upper portion of the Russian River watershed include hardwood and mixed forest, chaparral, grassland, orchards and vineyards, and riparian woodland species. The riparian woodland species include mule fact, sandbar willow, red willow, and Fremont cottonwood (McBride and Strahan, 1981; JARA, 1974). It is noted that most of the land located immediately downgradient of the CWP site is occupied by pear orchards. The surface drains and creeks located downstream of the CWP facility are seasonally vegetated with tulleys, sour dock, anise, wild rose, peppermint, and cattails.

The Russian River is important as a spawning ground for anadromous fish, of which the principal varieties are steelhead trout and silver (or coho) salmon. Other fish inhabiting the basin include king (or chinook) salmon, small-mouth bass, American shad, striped bass, and white catfish.

The Russian River basin supports a wide range of wildlife species, including a substantial population of blacktailed deer, bandtailed pigeons, and pheasants. Several species of small mammals

associated with agricultural land use, i.e. rats, mice, and rabbits, are also found in the area. The Russian River basin supports a variety of resident and non-resident waterfowl which utilize the river habitat for nesting and refuge (U.S. Army Corps of Engineers, March 1982).

4.0 *SUMMARY OF REMEDIAL INVESTIGATION FINDINGS*

This section summarizes the geologic, hydrologic, and soil/ground water quality data generated during the remedial investigations. Details of the remedial investigations have been submitted in a number of previous technical reports which are referenced as appropriate. The content and format of the summary of remedial investigation findings is in general conformance with the RAP guidelines (DHS, September 1987).

4.1 GEOLOGY

The discussion of regional geology and study area stratigraphy is based primarily on published water supply papers/geologic reports by government agencies, site-specific reports prepared by CWP's consultants, and discussions with regulatory agency project personnel. The discussion is intended to help interpret the stratigraphy encountered at the site in the context of the overall, regional geology and to identify and characterize the geologic units pertinent to the CWP project. The primary reference for regional geology is a U.S. Geological Survey (USGS) report entitled "Ground Water Resources in Mendocino County, California" (Farrar, July 1986). Other sources of information are referenced as appropriate.

4.1.1 Regional Geology

Mendocino County is located largely within that part of the Coast Ranges geomorphic province known as the Mendocino Range. The Mendocino Range is characterized by rocks of the Franciscan Complex. The geologic units exposed at the surface in the Ukiah Valley may be categorized as basement rocks or valley fill.

Basement rocks are considered to include all pre-Pliocene formations. About 95 percent of the surface exposures consist of

basement rocks of the Franciscan Complex. In the vicinity of the site, the Franciscan Complex has been divided into the Coastal Belt and the Central Belt based on lithologic and structural differences. The division between the two is located along the axis of the Ukiah Valley, with the Coastal Belt forming the mountains that bound the valley to the west, and the Central Belt forming the Mayacmas Mountains to the east. Valley fill refers to geologic units of Quaternary age or those that span late Tertiary and Quaternary age. Valley fill deposits are confined to several small basins along major surface drainage features and the thin alluvium in stream channels.

Physiographically, the site is located in the Ukiah Valley, a north-south trending alluvial basin formed by the Russian River and its tributaries. The valley fill within the Ukiah Valley has been subdivided by Farrar (July 1986) into three distinct units: continental basin deposits; continental terrace deposits; and Holocene alluvium. The distinction is made according to the age and origin of the materials, although several investigators (Cardwell, 1965; Farrar, July 1986) have reported difficulty in differentiating between these units on the basis of the descriptions usually available from well drillers logs. The areal distribution of the valley fill units (Cardwell, 1965; Farrar, July 1986) is shown in Figure 5. A schematic section through the Ukiah Valley, illustrating the stratigraphic relationship between the valley fill units, is shown in Figure 6.

Based on stratigraphic information obtained from available water well logs, a regional geologic cross section along the axis of the Ukiah Valley, parallel to the direction of ground water flow, has been prepared. The approximate locations of the water-producing wells, ground water contours, and the section line are shown in Figure 4. The regional geologic cross section is shown in

Figure 7. Each of the three valley fill units referenced above is described below, as they are believed to be the geologic units most relevant to the CWP project.

4.1.1.1 Continental Basin Deposits

The continental basin deposits are of Pliocene and Pleistocene age and represent the oldest of the valley fill units. The continental basin deposits were deposited unconformably over the basement rocks of the Franciscan Complex by landslides and debris flow from the adjacent highlands. Subsequent to deposition, the materials were reworked by gravity and stream processes.

The complex depositional process resulted in a heterogeneous mixture of loosely cemented gravel, sand, silt, and clay. The predominant material is clay which occurs in beds and as interstitial material between coarser grains of sand and gravel. The high clay content and poor sorting result in generally low permeabilities.

The thickness of the continental basin deposits ranges from zero along the margins of the Ukiah Valley to at least 500 feet near its axis. No outcrops have been recorded along the western margin of the Ukiah Valley near the site; however, extensive outcrops do occur along the eastern side. Reportedly, the continental basin deposits are likely to occur at depth, beneath younger valley fill deposits, over most of the Ukiah Valley (Farrar, July 1986).

4.1.1.2 Continental Terrace Deposits

The continental terrace deposits have been subdivided (Cardwell, 1965) into older and younger terrace deposits. Younger terrace deposits have been mapped along the western margin of the Ukiah Valley in the vicinity of the site. Most of the city of Ukiah, notably the downtown area along State Street, has been developed

on younger terrace deposits. The occurrence of the younger terrace deposits at the surface along the western margin of the Ukiah Valley is discontinuous where Robinson Creek emerges from the adjacent highlands. Although lithologically very similar to the continental basin deposits, the clay and silt content of the younger terraces is generally less. As in the continental basin deposits, vertical and lateral discontinuity of individual beds and lenses is common. The unit is generally considered to have low permeability.

The maximum thickness of the younger continental terrace deposits is not accurately known, as they are very difficult to differentiate from the underlying continental basin deposits.

4.1.1.3 <u>Holocene Alluvium</u>

The Holocene alluvium is composed of uncemented gravel, sand, silt, and clay. The alluvium reportedly covers broad areas of the Ukiah Valley in the vicinity of the site (Cardwell, 1965; Farrar, July 1986). The alluvium also extends into several smaller valleys associated with tributaries to the Russian River, most notably the valley associated with Robinson Creek. Within the central strip of the valley, along the Russian River, highly permeable, loose gravel and coarse sand deposits have been developed. These deposits are in direct hydraulic communication with the surface water in the Russian River.

The thickness of the Holocene alluvium is not accurately known, again because differentiation between the Holocene alluvium and the underlying continental basin deposits is very difficult. Areas of high porosity and permeability occur due to the uncemented, coarse-grained nature of localized sediments. These areas of high permeability are typically close to the present course of the Russian River.

4.1.2 Study Area Stratigraphy

Previous investigations by consultants to CWP (H. Esmaili & Associates, August 1981; J.H. Kleinfelder and Associates, November 1982; D'Appolonia, May 1984; IT Corporation, June 1985; Geosystem, January 1987) and by the RWQCB have included the installation of over 30 ground water monitoring wells and the drilling of numerous soil borings in the study area. Based on the information obtained from the above referenced investigations, attempts have been made to assess the stratigraphy encountered at the site in the context of the regional geology. Cardwell (1965) has mapped the contact between the younger continental terrace deposits and the Holocene alluvium as bisecting the CWP site as shown in Figure 5. Based on the stratigraphic information available from the majority of the borings in the study area, however, it has not been possible to differentiate between these units. As the terrace deposits are typically slightly elevated, it is possible that Cardwell originally mapped the contact based on topographic relief. If so, the construction of U.S. Highway 101 and the overall development of the area appears to have obliterated any such evidence of this contact.

Based upon a review of the stratigraphic logs recorded during the site characterization studies, it appears that the materials encountered in the study area generally correspond with the continental basin and terrace deposits. The presence of elevated terraces and the incised nature of the Russian River are indicative of changes in stream level, probably as a result of recent continued uplift of the region. Consequently, erosional processes predominate over depositional processes and the more coarse-grained, highly permeable sediments characterized as Holocene alluvium may be limited to a narrow strip adjacent to the Russian

River channel. The relatively large number of shallow, high production wells immediately adjacent to the Russian River supports this geologic conceptualization.

The stratigraphic information recorded on the available drilling logs has been used to construct subsurface profiles A-A′ and B-B′, which are shown in Figures 8 and 9, respectively. As shown in the subsurface profiles, the stratigraphy in the site area is characterized by numerous and abrupt lateral facies changes. These conditions reflect a fluvial environment in which the depositional conditions were constantly changing, ranging from a very low hydraulic energy (deposition of silt and clay) to high energy (deposition of sand and gravel). The stratigraphy is, therefore, complex and correlation of the various units is not self-evident. There are, however, general lithologic trends which are functional in terms of the hydrologic behavior of the sediments and the migration of chromium. Based on these trends, four zones, Zones 1 through 4, have been defined under the site.

Zone 1 is the uppermost of the four zones. The stratigraphic information indicates that Zone 1 is continuous throughout the site and immediate downgradient vicinity. Zone 1 has been reworked and graded during the development of the CWP site and the construction of Taylor Drive and several surface drainage features. The lower boundary of Zone 1 is defined by a blue, clayey silt/silty clay, gleyed horizon. Zone 1 is underlain in sequence by Zones 2, 3, and 4.

As the majority of the borings drilled for soil sampling and monitoring well installation purposes were relatively shallow, the areal extent of Zone 2 is less well defined. The available information, however, indicates that Zone 2 may be continuous from Well CWP-17 on site to Well AT-4 off site (Figures 2 and 8).

Little information is available regarding the continuity and areal extent of Zones 3 and 4; however, it is noted that they are not of prime importance relative to the possible migration of chromium in ground water. Each of Zones 1 through 4 is described below.

4.1.2.1 Zone 1

Zone 1 is considered to extend vertically from the ground surface to a depth of approximately 20 feet. Zone 1 consists primarily of silty clay, clayey silt, and clayey sand, with more permeable stringers and lenses of silty sand and gravel. The silty clays and clayey silts are generally stiff to very stiff, low to moderately plastic, and locally contain carbon granules and healed root holes. The colors of the soils in Zone 1 have been recorded as yellow brown to mottled gray and brown. Varying amounts of very soft, deeply weathered fragments of sedimentary rocks (predominantly mudstone) are present in the clay. Based on the generally variegated appearance and embedded rock fragments in a clay matrix, it is believed that the clay has been developed in situ from the younger terrace deposits. Stringers of gravel and fine sand are present in the clay which yield varying, but generally limited, quantities of water. As shown in Figures 8 and 9, the lateral continuity of these stringers is thought to be limited as correlation for significant distances does not appear to be possible.

Zone 1 is considered to be the zone most impacted by chromium compounds. The lateral migration through this zone appears to be limited to the irregular, more permeable sand and gravel lenses. The off-site migration of chromium in these more permeable strata has been retarded by the installation of the slurry cutoff wall and ground water extraction from Well HL-7. The slurry cutoff wall reportedly extends throughout the full depth of Zone 1. The

vertical migration through the soils within Zone 1 is believed to be very slow because of the apparent heterogeneity and discontinuity of permeable lenses.

The lower boundary of Zone 1 is considered to be the very stiff, blue, gleyed, clayey silt/silty clay layer which is typically 4 to 5 feet thick. The gleyed and relatively uniform quality of this stratum indicates a well-weathered (older) development and low hydraulic conductivity. As shown in Figures 8 and 9, this blue clay/silt layer has been intercepted by numerous borings at the site and correlates reasonably well from the center of the site as far south as Boring AT-5. This stratum is less well defined near the retorts; however, it is noted that the topography in this area is elevated and the borings are generally shallower. The blue clay/silt layer appears to limit downward migration of chromium from Zone 1 to Zone 2.

The correlation of this stratum depends primarily on its distinctive blue coloration. The apparent absence of this blue clay/silt layer in some borings (CWP-13 and CWP-17) may be attributable to geologic conditions and/or to sampling and descriptive procedures. For example, as shown in Profile A-A' (Figure 8), the blue clay/silt layer was encountered in Well CWP-22; further to the north, however, in Well CWP-13, the fine-grained sediments have been replaced by a sandy facies. It is possible that the blue clay/silt layer was deposited and later eroded and replaced by a channel-fill, representing a higher energy facies. On the other hand, the omission may be due to the sampling interval, as compared with the thickness of the layer.

4.1.2.2 Zone 2

Zone 2 consists of a sand and gravel layer which varies from approximately 5 to 10 feet thick. The sands and gravels in Zone 2

generally contain appreciable amounts of silt and clay, and are dense and slightly cemented in some areas. Most of the gravel is subangular and less than one-half inch in size. Stringers of poorly graded fine sand and medium coarse sand are also present. In Boring AT-4, a thin layer of silt is present within Zone 2.

Zone 2 is believed to be the most significant water producer of the four zones in the site area. As shown in Figure 8, Zone 2 can be correlated between the deep borings from south of the retort area to off-site areas. Zone 2 appears to decrease in thickness to the southeast and was not encountered at all in Boring AT-5. This may suggest that Zone 2 is discontinuous to the southeast or is confined to channels which were not intercepted by Boring AT-5.

4.1.2.3 Zone 3

Zone 3 is considered to be the stiff, olive-brown, clayey silt stratum that forms the lower boundary of Zone 2. Zone 3 has been encountered in several borings, as shown in Figure 8, and can be correlated from off-site areas around Well AT-4 to Well CWP-13 at the site. The thickness of Zone 3 appears to vary from 4 to 6 feet. The low permeability of the soils in Zone 3 are expected to significantly restrict the vertical movement of ground water.

4.1.2.4 Zone 4

Zone 4 is considered to be the clayey sand and gravel stratum which underlies Zone 3. As shown in Figure 8, this stratum appears to be continuous from the pear orchard to at least the eastern boundary of the site. The sparsity of deep borings in the northern and western portions of the site does not permit further correlation. It is noted, however, that the permeability of Zone 4 appears to increase to the southeast. In Boring CWP-13, Zone 4 is characterized as a medium to coarse sand with some silt and gravel;

and in Boring AT-5 as a clean sand and sandy gravel. The water producing characteristics of Zone 4 vary accordingly.

An alternative scenario for the varying permeability is that to the northwest, Zone 4 represents the terrace deposits described in Section 4.1.1.2. To the southeast, Zone 4 may represent the Holocene alluvium associated with the Russian River or Robinson Creek.

4.2 GROUND WATER HYDROLOGY

The following sections provide a summary of general ground water conditions in the valley fill deposits of the Ukiah Valley and a description of ground water occurrence in the strata encountered beneath the CWP site.

4.2.1 Regional Ground Water Conditions

Ground water occurs primarily in the valley fill deposits in the Ukiah Valley. In the continental basin deposits, ground water occurs under confined conditions and wells completed in this unit generally produce water "slowly" because of the fine-grained nature of sediments. The specific capacities of 30 wells completed in the continental basin deposits range from 0.004 to 1.33 gallon/minute/foot and "dry holes" are not uncommon (Farrar, July 1986).

Because they are relatively thin and impermeable, the younger terrace deposits are not considered a major source of ground water. Wells completed in the terrace deposits may yield sufficient water for low-capacity domestic or stock-watering wells. Specific capacities of wells completed in the terrace deposits range from 0.02 to 7.1 gallon/minute/foot and fluctuations in the water table can "drastically" affect well performance (Farrar, July 1986).

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The Holocene alluvium is considered the most productive water-bearing unit in the Ukiah Valley and provides "sufficient water for sustained pumpage for municipal and irrigation wells." The more permeable, coarser-grained sediments appear to be located along the present course of the Russian River, as evidenced by several, high-production wells. These include community water supply wells operated by the Willow County Water District (WCWD), including Wells 14N/12W-9A1 and -9A2 and Wells 15N/12W-33E3, -33E4, -33E5, and -33E6. The locations of these wells are shown in Figure 4. Also, a series of wells has been installed along the western bank of the Russian River from south of the Ukiah Sewage Disposal facility to the El Robles Ranch. This series of wells, shown in Figure 4, includes Wells 14N/12W-4B, -4G, -4Q, -4R1, and -4R2. These wells supply water for irrigation and are believed to derive a portion of their production from surface water in the Russian River, induced to flow through permeable alluvial deposits as the ground water level is lowered by pumping. It has been reported (Farrar, July 1986) that under most flow conditions, ground water moves from the alluvium into the Russian River. During periods of high water levels in the Russian River, however, the reverse situation occurs.

On a regional basis, ground water in the valley fill deposits flows approximately north to south along the axis of the Ukiah Valley. Near the west margin of the valley, however, ground water generally flows to the east, following the topography. Regional ground water contours are shown in Figure 4.

4.2.2 <u>Study Area Ground Water</u>

In the study area, ground water occurs primarily in stratigraphic Zones 1 and 2. The following discussion focusses on these strata, as they are of primary concern regarding the migration of chromium.

The ground water flow direction and hydraulic gradient have been established from water level data accumulated throughout the investigations performed at the site. These data are summarized in Table B.1 of Appendix B. Based on water level measurements in monitoring wells completed in Zone 1, made by CWP personnel in January 1987, Zone 1 ground water contours have been generated. These Zone 1 contours are shown in Figure 10. The Zone 1 ground water contours indicate an overall southeasterly direction of flow with a hydraulic gradient of about 0.005. This is consistent with the direction of regional ground water flow shown in Figure 4. In off-site areas to the southeast of the site, the contours indicate a flow direction to the south with approximately the same hydraulic gradient.

As shown in Table 1, there are only three ground water monitoring wells, Wells CWP-15, CWP-22, and AT-4, completed exclusively in Zone 2. These three data points are not sufficient to generate ground water contours in Zone 2. Comparison of the ground water levels in Wells CWP-15, CWP-22, and AT-4 with those in adjacent Zone 1 monitoring wells, however, indicates that the Zone 2 water levels are approximately 1-foot below those in Zone 1. Several other wells (Wells CWP-7, CWP-8, CWP-9, CWP-14, and CWP-19) are completed in Zones 1 and 2. The water levels in these wells generally appear to reflect Zone 1 ground water levels.

The hydraulic properties of the water-bearing zones have been investigated by previous consultants and Geosystem by means of several pumping and slug tests (Geosystem, March 1986). The data collected throughout these investigations have been summarized by Geosystem (September 19, 1986). These data suggest that hydraulic conductivities of Zones 1 and 2 are generally on the order of 10^{-3} to 10^{-2} cm/sec. Zones 3 and 4 were considered to have lower permeability; however, more recent stratigraphic data (Geosystem,

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January 1987) suggest that Zone 4 may be highly permeable to the southeast of the site. Zones 3 and 4 are of less importance to the remediation of chromium in off-site areas. A summary of the hydraulic properties of Zone 1 is presented in Table 5 and a summary of the hydraulic conductivity data obtained by field tests throughout the course of the site characterization studies is presented in Table 6.

4.3 <u>SURFACE WATER HYDROLOGY</u>

The Russian River, which originates in central Mendocino County and flows south to Sonoma Coast State Beach, is the most important surface drainage system in the Ukiah Valley. At its closest point, the Russian River flows approximately 2,000 feet to the east of the CWP site. Flow in the Russian River is regulated by controlling the contributions from several of its major tributaries. Minimum flows are required to be maintained, however, at various locations on the Russian River. One of these locations is at the junction of the East and West Forks of the Russian River, just north of Ukiah. At this point, a minimum flow of approximately 150 cfs is required (DWR, May 1980). The Russian River has numerous beneficial uses, as described in Section 4.4.1.

Tributaries to the Russian River include numerous small streams issuing from the mountains that border the Ukiah Valley to the east and west. The most significant of these tributaries in the vicinity of the CWP site is Robinson Creek, which merges with the Russian River at a point about 4,500 feet to the southeast. The locations of the Russian River and Robinson Creek, relative to the CWP site, are shown in Figure 1.

Flow in Robinson Creek occurs essentially year round and follows the natural drainage course. Other, smaller surface drainage features flow only when precipitation occurs in the Ukiah Valley

or the adjacent highlands. Observations by CWP personnel indicate that, depending on the intensity and duration of the rainfall, flow in these smaller surface drainage features may reach the Russian River or percolate into the valley fill prior to reaching the river. During the winter months, when the water table rises to within 2 or 3 feet of the land surface, ground water may flow into the low-lying surface drainage ditches. Under these circumstances, water would be present in the ditches even when no precipitation is occurring. Such water would not, however, be representative of storm water runoff originating from the CWP site.

Flow in the majority of these smaller surface drainage features is intermittent and is controlled and diverted by culverts and ditches. Several small ditches and culverts divert surface water runoff around and beneath the CWP site. The locations of the ditches and culverts in the immediate vicinity of the site are shown in Figure 2. The ditches that flow beneath and around the CWP site report to a common ditch that flows south, parallel to and east of Taylor Drive. This common ditch flows east along the northern boundary of the Alex Thomas pear orchard and bends south along the railroad tracks. Flow in the ditch, by now augmented by runoff from the pear orchard and the railroad corridor, enters an east-west lateral drain which discharges to the Russian River. It was observed, in October 1987, that the lateral ditch contained small amounts of water; however, the other tributary ditches were dry.

Surface water quality in the Russian River is considered to be of "excellent to good quality" in terms of mineral content (DWR, May 1980). Using electrical conductivity (EC) as an indicator of mineral content, water quality standards recommend an EC of less than 450 micromhos. The average EC of Russian River water, between Potter Valley to the north of Ukiah and Hopland to the south,

ranges from 140 to 190 micromhos. The average hardness is 115 mg/l (as $CaCO_3$), which is considered to be moderately hard and not likely to adversely affect most beneficial uses (DWR, May 1980). High, non-organic turbidity is an occasional problem in the Russian River and its tributaries during periods of prolonged rainfall and release of water from Lake Mendocino. This turbidity may also be aggravated by the removal of gravel, for use in construction, as the disturbed river channel can contribute significant turbidity to water in the Russian River.

4.4 BENEFICIAL USES OF WATER

This section summarizes the known beneficial uses of surface and ground water in the Ukiah Valley in the vicinity of the CVP site. The beneficial uses of surface and ground water have been summarized primarily from available reports published by various state government agencies. The sources of information are referenced as appropriate. An inventory of water-producing wells in the vicinity of the site has also been performed. In addition to aiding assessment of the beneficial uses of ground water, the purpose of the well inventory was to identify and locate wells in the vicinity of the site and document well construction details.

For the purpose of this discussion, and to maintain consistency with DWR water supply assessment procedures, surface water is considered to be "water flowing in the various stream courses plus underflow. Underflow may be defined as subsurface water contained in the channel deposits, which if extracted, would affect stream flow within a short period of time" (DWR, May 1980). It is not uncommon to install wells in the coarse, stream channel deposits immediately adjacent to the Russian River and extract underflow. As the underflow and surface waters are in direct hydraulic communication, extracted underflow is considered to be surface water.

4.4.1 Surface Water

The Russian River is a major municipal water supply for Mendocino, Sonoma, and Marin Counties. In addition to municipal supply, water from the Russian River is used for agricultural, industrial, and recreational purposes.

According to the Water Quality Control Plan for the North Coastal Basin, the specific beneficial uses of the Russian River include:

- o Municipal and domestic supply.
- o Agricultural supply.
- o Industrial service supply.
- o Industrial process supply.
- o Ground water recharge.
- o Navigation.
- o Potential hydropower generation.
- o Contact water recreation.
- o Non-contact water recreation.
- o Warm freshwater habitat.
- o Wildlife habitat.
- o Fish migration.
- o Fish spawning.

Other than contributing to the Russian River, little information is available regarding direct beneficial uses of the numerous small tributary streams. The beneficial uses of water in the tributary ditches flowing around the CWP site, however, include wildlife habitat and, during portions of the year, freshwater habitat. In addition, ground water recharge is a beneficial use of the water in these tributaries.

The approximate volume of surface water for agricultural and urban use in 1975 was estimated to be 10,600 and 6,000 acre-feet, respectively. The demand on surface water resources is projected to increase to about 14,200 and 6,800 acre-feet for agricultural and urban use, respectively, by the year 2000 (DWR, May 1980).

4.4.2 Ground Water

Beneficial uses of the ground water resources in the vicinity of the CWP site include primarily community water supply, domestic water supply, and irrigated agriculture.

In general, well location and the particular unit of the valley fill in which a well is completed influence yield and the beneficial use of the extracted water. Wells completed in the continental basin and terrace deposits generally yield ground water in amounts suitable only for low-capacity domestic wells, stock-watering wells, or limited irrigation wells (Farrar, July 1986). Wells completed in the Holocene alluvium can yield sufficient water under sustained pumping for municipal and irrigation supply. WCWD extracts ground water from wells located in the Norgard Lane well field, approximately 2,200 feet north of the CWP site, and from two wells near the Russian River, approximately 8,000 feet south of the CWP site.

4.5 SOIL, STORM WATER, AND GROUND WATER QUALITY

This section presents the distribution and occurrence of chromium and other indicator parameters in soil, storm water, and ground water in the study area. Throughout the remainder of this report, hexavalent chromium is referred to as Cr(VI) and trivalent chromium is referred to as Cr(III). Unless specified otherwise, chromium refers to total chromium. Water and soil quality data have been generated over several years of site characterization studies and monitoring. Ground water, storm water, and soil quality data are contained in Appendices B, C, and D, respectively, and are summarized in the following sections.

4.5.1 Distribution of Chromium, Arsenic, and Copper in Soil

A total of 26 soil borings (Borings S-1 through S-26) were drilled (D'Appolonia/IT Corporation, May 1984) in the study area to assess

the areal extent of chromium, arsenic, and copper in soil to a depth of about 20 feet. Soil samples were collected at depths of 1, 3, 6, 10, 15, and 20 feet. Near-surface soil samples from depths of 1 and 2 feet were also collected from 17 other locations (G-1 through G-17) to further delineate the areal distribution of chemicals in near-surface soils. The locations of the soil sampling stations are shown in Figure 11. All soil samples were analyzed for total or hexavalent chromium, arsenic, and copper. A summary of the data is presented in Tables D.1 through D.4 of Appendix D. Plots of chromium concentrations with depth for selected borings are also included in Appendix D. All concentrations reflect the total quantity of the metals present in the samples. The Sample ID provides a designation for either a boring (S) or a surface sample (G), followed by a number identifying the location. The last number in the designation identifies the depth at which the sample was collected. From a general review of the data, the following observations can be made:

- Elevated chromium concentrations exist in the upper 3 feet of soil and especially in the top 1 foot (G-10, 1'; S-4, 1'; S-8, 0'; S-5, 0').
- Chromium concentrations in samples collected from more than 3 feet below the surface are generally lower than 50 mg/kg in all borings, except in S-8 at the 10-foot depth and S-10 at the 15-foot depth.
- Chromium concentrations are higher in borings near the retort and sump areas.
- The maximum detected concentrations of chromium, copper, and arsenic in surficial soils are 540, 230, and 220 mg/kg, respectively (Appendix D).
- Generally, there appears to be good correlation between chromium, arsenic, and copper concentrations.

In order to compare background chromium concentrations, in areas not affected by CWP operations, with areas that are possibly

impacted by wood preserving operations, the data for Borings S-1 (upgradient), S-26 (background), S-5, S-8, S-10 (retort and sump area), S-15, S-22, and S-25 (downgradient) have been summarized in Table D.4 (Appendix D). Boring S-8 is located at the eastern end of the rail lines and Boring S-10 is the closest boring topographically downgradient of the retorts. It should be noted that no samples have been collected from under the retort/process area. Sampling in these areas is not possible during normal facility operation. The salient features of the data include the following:

- o Higher chromium concentrations are observed in the surface samples near the retort and sump areas.
- o Chromium concentrations in Boring S-1 (upgradient) samples collected below the 3-foot depth are generally in the same range as those observed in other borings.
- o The background and upgradient concentrations of chromium, arsenic, and copper in Borings S-26 and S-1 samples are generally less than 50 mg/kg less that 14 mg/l, and less than 20 mg/kg respectively.

Soil samples containing chromium concentrations greater than 100 mg/kg were selected to represent surface soils with definite chromium contamination. The approximate area of such contamination is shown in Figure 11. The majority of the surface soils containing elevated chromium concentrations are in the area around the retort and sump units where freshly treated wood has been stored. A narrow band of surface soils with approximately 100 mg/l of chromium is present to the south of the retort chambers.

4.5.2 Storm Water Quality

This section summarizes the available water quality data obtained from storm water samples collected at the CWP site. Flow in the ditches and culverts around and beneath the CWP site occurs as a

result of precipitation in the Ukiah Valley or the adjacent highlands. As noted in Section 4.3, ground water may be present in low-lying drainage ditches on a continuous basis during the winter months. A differentiation is made, however, between this water and storm water runoff.

A surface or storm water monitoring program is in effect at the site and several storm water monitoring locations have been established. Currently, the storm water monitoring program includes collection of samples from Stations NE, NW, and C-100. Up until December 1984, Stations SE and SW were also monitored. The locations of these stations are shown in Figure 2. Prior to instituting surface water flow control at the CWP site, storm water samples were periodically collected and analyzed. RWQCB staff have indicated that the measured concentrations of metals in 1980 and 1981 were much higher than in subsequent years.

Monitoring Station NW is located at the entrance to the culvert that conducts storm water under the CWP site from the west side of U.S. Highway 101. The water quality data collected at this location is considered to represent upgradient or background conditions.

Monitoring Station NE is located on Taylor Drive at the confluence of the above mentioned culvert and the ditch around the northeastern portion of the perimeter of the CWP site. Data collected at this location provide an indication of the quality of surface runoff from the northern portion of the CWP site. It is noted, however, that asphalt berms have been constructed to divert surface runoff from treated wood storage areas to a collection sump. From this sump, the water is recycled into CWP's wood preserving operations.

Monitoring Station C-100 is located approximately 100 feet downstream of the confluence of flow passing from Station NE and that flowing beneath the CWP site through a second culvert near the southern site boundary. Comparison of data collected from this location with that from Monitoring Station NW provides an indication of the overall impact of surface runoff from the CWP site on storm water quality.

It is noted that areas other than the CWP site also contribute to flow at all three storm water monitoring stations. The possible impact of these contributions must be considered when evaluating storm water quality.

Storm water samples are currently analyzed for dissolved total chromium and arsenic; however, in the past, analyses for dissolved Cr(VI) and copper have also been performed. The most recent and comprehensive data, representing January 1988, are presented in Table 7. The historical storm water quality data are summarized in Appendix C. The data indicate that chromium, arsenic, and copper are occasionally present at detectable concentrations in storm water flow sampled at Stations NE and C-100. It is noted, however, that the measured concentrations are typically close to the detection limits and the concentration of Cr(VI) has occasionally exceeded the drinking water standard of 0.05 mg/l within the last five years. Chromium, arsenic, and copper concentrations in samples collected from Monitoring Station NW have been at or below detection limits since 1983, with the exception of arsenic which was measured at 0.006 mg/l in January 1986 at Station NW. The most recent data, representing April 1988, show non-detectable concentrations of chromium and arsenic in Monitoring Stations C-100, NE, and NW.

In addition to CWP's monitoring, the RWQCB staff have obtained storm water samples since 1984 which have been analyzed for Cr(III), Cr(VI), arsenic, and copper. The potential impact from past and current discharges are discussed in Section 6.0.

4.5.3 Ground Water Quality

Ground water quality monitoring has been performed at the CWP site since 1981. The chemical analyses have generally included total dissolved chromium, arsenic, and copper with occasional measurements of dissolved Cr(VI). The most recent, comprehensive ground water quality data are presented in Table 7. All historical ground water quality data have been summarized in Table B.2 of Appendix B. The water quality data indicate that:

- The wells completed in Zone 1 near the retort area generally exhibit higher chromium concentrations and the concentrations decrease hydraulically downgradient.
- The maximum detected concentrations of total chromium and hexavalent chromium in ground water occurred in Well CWP-6 at 125 and 78 mg/l, respectively.
- Chromium concentrations have generally decreased with time. Wells CWP-2A, CWP-2B, CWP-6 (near retort area), CWP-8, CWP-11 (near site boundary), and FPT-3, FPT-4, FPT-5, AT-2 (off-site) support this observation.
- The concentrations of chromium in on-site wells completed in Zone 2 are not significant and may result from limited communication with Zone 1.
- Zone 2 does not contain elevated chromium concentrations in off-site areas.
- Zones 3 and 4 do not appear to be impacted by the presence of chromium.

Selected ground water quality data have been used to generate chromium isoconcentrations to provide an areal representation of

the chromium plume in ground water. Data from January/February 1986, April 1987, and January 1988 are the most recent and comprehensive sets of data which are used to plot isoconcentrations, as shown in Figures 12, 13, and 14, respectively. These figures indicate that elevated chromium concentrations are present in ground water primarily in on-site areas to the west of the slurry wall. Comparison between the three sets of isoconcentrations indicates the apparent trend of decreasing chromium concentrations with time in monitoring wells located hydraulically downgradient of the slurry cutoff wall. It should be noted that these isoconcentrations have been developed based on data obtained from all wells and do not differentiate between the various stratigraphic zones. However, the data represent primarily the water quality of Zone 1.

Of the ground water monitoring wells located hydraulically downgradient of the slurry cutoff wall, only Wells CWP-8 and AT-2 have occasionally indicated the presence of chromium in excess of the drinking water standard (0.05 mg/l). In 1988, chromium concentrations in Well CWP-8 exceeded the drinking water standard twice. Other observations showed chromium concentrations at or below the detection limit of 0.02 mg/l. In 1988, chromium concentrations in Well AT-2 ranged from less than 0.02 to 0.05 mg/l. Eight observations showed less than 0.02 mg/l chromium concentrations. Well AT-2 is completed entirely within Zone 1; however, other Zone 1 monitoring wells downgradient of Well AT-2 have not shown the presence of chromium. Also, Zone 2, in the vicinity of Well AT-2 does not contain detectable levels of chromium (Geosystem, January 1987).

To demonstrate the trend of decreasing chromium concentrations with time, water quality data obtained from Wells CWP-6, FPT-3, and AT-2 have been plotted in Figures 15, 16, and 17, respectively. The

reduction in concentration is more evident in off-site Wells FPT-3 and AT-2 as compared with on-site Well CWP-6. The decline in chromium concentration with time in Well CWP-8, on a semi-logarithmic basis, is shown in Figure 18. The area near Well CWP-8 is assumed to be the potential source of chromium to off-site areas, since it is to the east of the slurry wall and not contained by on-site remediation efforts. The water quality data for Well CWP-6 (Figure 15) show a considerable reduction in chromium concentrations from over 120 mg/l in 1981 to about 50 mg/l in June 1985. Since 1985, chromium concentrations have varied somewhat; however, the overall concentrations have not changed significantly. Similar reductions in chromium concentrations can be observed in Figures 16 and 17 for Wells FPT-3 and AT-2, respectively. The chromium concentrations in Wells FPT-3 and AT-2 generally demonstrate a steady decline in chromium concentrations. The chromium concentration in Well FPT-3 has been below the drinking water standard of 0.05 mg/l since February 1986. Also, the most recent water quality data for Well AT-2 (Table B.2 of Appendix B) indicate the concentration of chromium is generally below the drinking water standard of 0.05 mg/l (Geosystem, February 1988). The trends in chromium concentrations in off-site areas are discussed further in Section 6.0, which addresses migration pathways and risk assessment.

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4.6 INDICATOR PARAMETERS

Site characterization studies have shown the presence of chromium, copper, and arsenic in soil and the presence of chromium in ground water. These compounds, therefore, are considered to be indicator parameters for use in further site characterization studies and possible soil remediation activities. For monitoring and ground water remediation, however, dissolved total chromium and Cr(VI) are considered to be the most relevant indicator parameters. The rationale for this selection is that chromium compounds,

particularly Cr(VI), are more soluble and more mobile in the subsurface environment than arsenic and copper compounds. In addition, previous monitoring efforts have not detected copper or arsenic in ground water.

4.7 GEOCHEMICAL PROPERTIES

To evaluate the migration rate and leaching characteristics of chromium, a number of geochemical tests were performed. These tests included chemical analyses for total chromium, Cr(VI), organic matter, Waste Extraction Tests (WET), batch sorption tests, and column desorption tests. Detailed descriptions of these tests and test results have been submitted previously (IT Corporation, June 1985); however, the findings of these studies, pertinent to the RAP, are summarized below.

4.7.1 Soil Sample Analyses

Nine soil samples were selected for analyses to determine the relative concentrations of total chromium and Cr(VI). The results are presented in Table D.5 of Appendix D. The data show that the concentrations of Cr(VI) in the samples analyzed are generally less than 10 percent of the total chromium content. From the data it can be concluded that most of the chromium present in the soil is not in hexavalent form. Previous studies have shown that the trivalent forms of chromium under neutral conditions are less soluble and more subject to adsorption. Cr(III) is, thus, less susceptible to dissolution and is less mobile.

The organic content of the soil samples, reported in Table D.5 of Appendix D, varied from less than 0.1 to 0.86 percent. Although the organic content of the soil may not be directly responsible for adsorption of Cr(VI), it may reduce Cr(VI) to Cr(III) (Stollenwerk and Grove, 1985; James and Bartlett, 1983). Because

of the complexity of the geochemical reactions, the overall effect of organic matter on the reduction of Cr(VI) to Cr(III) can not be assessed.

4.7.2 Waste Extraction Tests

To evaluate the leaching characteristics of the contaminated soil with respect to dissolved total chromium, Waste Extraction Tests (WET) were performed according to the guidelines issued by the DHS (January 1984). The rationale for performing the tests for total chromium was that it has been shown that a large percentage of the chromium in the soil is in trivalent form. The WET results are presented in Table D.6 of Appendix D. The results show that according to existing criteria the soil is not considered a hazardous waste. Although the WET results do not provide any information on the long-term leachability of Cr(VI), the test was designed to evaluate the leaching characteristics of total chromium in soil under aggressive acidic conditions. The long-term leaching behavior of Cr(VI) could be assessed if sufficient field data were available. At this time, however, the collection and evaluation of such data, under partially saturated flow conditions and in heterogeneous soils, is still in the research stage.

4.7.3 Sorption Tests

To evaluate the migration characteristics of Cr(VI) in ground water, batch sorption tests were performed on uncontaminated soil samples. The tests were performed on two samples; one representing the silty clay material of Zone 1 and the other the sand and gravel of Zone 2. The tests were performed for two initial concentrations of 1 and 10 mg/l. The results demonstrated that the distribution coefficient (K_d) varies from 0.65 to 2.98 ml/g and the corresponding retardation factors (R) range from 4.9 to 12.4. The retardation factor of 4.9 represents the minimum calculated value for the sand and gravel layer.

The results of batch sorption tests demonstrate that adsorption on the soil matrix can occur, retarding the migration of Cr(VI). Even though all the adsorption mechanisms and their relative contributions are not known, the results of previous studies (Stollenwerk and Grove, 1985) support the conclusion that adsorption of Cr(VI) on alluvial materials is likely. This is particularly true for soils containing high concentrations of iron oxides. The results of the sorption tests have been utilized in evaluating the migration behavior of chromium (Section 6.0).

4.7.4 Desorption Tests

Desorption tests have been performed to evaluate the behavior of Cr(VI) in the pore fluid as noncontaminated water flows through contaminated soil. Two soil samples, one classified as sandy gravel and the other as clayey silt, were used for the desorption studies. Solutions of sodium chromate were first used to contaminate the soil samples. The initial concentration of the influent to the soil columns was 10 mg/l. However, since achieving steady state conditions appeared to be very slow, the influent concentrations were increased to 190 mg/l. The result of the contamination phase of the desorption tests showed that more than 70 pore volumes were required to achieve steady state conditions. This may be an indication that the soils exhibit a considerable adsorptive capacity for Cr(VI). Limited data on the iron content of the soils underlying the site indicated the presence of about 23,500 mg/kg of iron. Oxides and hydroxides of iron may contribute to the adsorption of Cr(VI) (Stollenwerk and Grove, 1985; James and Bartlett, 1983).

The desorption phase was conducted by replacing the influent solution with distilled water. The data showed that about 10 pore volumes were required to reduce the effluent concentration of

Cr(VI) from approximately 185 mg/l to about 0.1 mg/l. The results also showed that, in the low concentration range, the rate of reduction in concentration was very slow. However, it should be noted that desorption per se is not a slow process.

It should also be pointed out that the sorption and desorption studies were conducted using distilled water as a solvent. This may affect the sorption/desorption characteristics as compared to the actual field conditions where the ground water contains a number of other chemical compounds. For instance, the adsorption of Cr(VI) in the presence of other salts may be reduced (Stollenwerk and Grove, 1985) and the desorption may be enhanced. However, the laboratory data using distilled water are considered to have generated useful information under highly controlled conditions. Since the ground water characteristics vary with time under actual field conditions, it appears that the long term geochemical behavior can best be evaluated by studying field data. The advantage of this approach is that any observations reflect the aggregate effect of all hydrogeologic and geochemical processes occurring in the field.

The ground water level fluctuations and water quality data have been reviewed to assess possible correlation between ground water level and chromium concentrations. Although certain wells exhibited a discernable trend of increasing chromium concentrations with rising ground water levels, the majority of the data do not suggest a relationship between the two factors. The column desorption test data have been used to estimate the duration of aquifer cleanup in terms of pore water volumes extracted as discussed in Section 7.0

5.0 INTERIM REMEDIAL MEASURES

Since the initiation of investigations at the CWP site, a number of improvements have been made to the facilities and several interim remedial measures have been implemented. Overall improvements to the CWP facility include extension of the area covered by surface paving, erection of canopies over the wood treatment area, and construction of berms to divert and control surface runoff from treated wood storage areas. Specific remedial measures include construction of a slurry cutoff wall, installation of a ground water extraction trench upgradient of the cutoff wall, and installation of a ground water extraction well near the retort area. Each of these measures is described in the following sections.

5.1 GENERAL FACILITY IMPROVEMENTS

In response to RWQCB requests and on a voluntary basis, over the past several years, CWP has implemented a number of measures to reduce and control surface runoff and eliminate the source of chromium to soil and ground water. These measures have included grading and construction of berms to prevent surface runoff from the retort and treated wood storage areas, surface paving, and the construction of roofs over the retort area. Surface grading and berm construction was performed in 1981 and focussed primarily on the retort area and areas used to store treated wood. The locations of the berms are shown in Figure 2.

The asphalt paving was extended to the northern and southern portions of the site in 1979 and 1981, respectively. The areal extent of the surface paving is shown in Figure 2. With the exception of the narrow strip to the east of the slurry wall, the remaining unpaved areas, as defined in Figure 2, will be paved. The paving serves to reduce the amount of water seeping into the

soil and possibly leaching chromium into ground water in areas of elevated chromium concentration. In addition, the paving reduces the likelihood of spilled wood preservatives and drippings from treated wood directly infiltrating the soil. Forklifts and other equipment used to handle treated wood are required to remain in certain areas to avoid tracking of wood preserving chemicals to areas where surface runoff is not controlled.

Three large roofs or canopies were erected in 1985 over the retort and adjacent area, as shown in Figure 2. These covers prevent precipitation from falling directly onto surfaces where wood preserving chemical drippings from treated wood may be present. The clean rain water running off these roofs eventually reports to surface drainage ditches around the CWP facility.

It was observed that the concrete utility box around Well CWP-10, located near the retort area, became filled with water during heavy precipitation at the site. Samples of water from the utility box were collected and analyzed. The results indicated high chromium concentrations. Ground water samples from Well CWP-10 had also indicated a sudden increase in chromium concentrations, from non-detected to relatively high concentrations (Appendix B). It was concluded that Well CWP-10 was conducting chromium-containing surface runoff to ground water. Well CWP-10 was subsequently abandoned by grouting.

5.2 SLURRY WALL AND EXTRACTION TRENCH

In October 1983, CWP constructed a slurry cutoff wall along the eastern site boundary. The slurry wall is reportedly about 300 feet long and 20 feet deep. CWP also installed a ground water extraction trench immediately to the west, hydraulically upgradient of the slurry wall. The extraction trench is approximately 15 feet long, 18 feet deep, and 2 feet wide. The trench is gravel-filled

and a 12-inch diameter extraction well, Well HL-7, is located approximately at the mid-point of the trench. The well casing is perforated from 9 to 19 feet below grade and is equipped with a permanent, electric submersible pump. Ground water extracted from the trench via Well HL-7 is used directly in CWP's wood preserving operations or transferred to the recycled water tank for subsequent use.

The slurry wall is intended to intercept the plume of dissolved chromium originating near the retort area and migrating to the southwest in the direction of ground water flow. The slurry wall location and configuration was based on the known chromium plume at the time. The extraction trench and Well HL-7 are intended to remove ground water impounded behind the slurry wall to prevent flow around the northern and southern ends of the wall. It should be noted that the slurry wall and the trench were constructed by CWP without the approval of the RWQCB and without professional supervision.

5.2.1 Recycling/Treatment of Extracted Ground Water

In the drier summer months, extracted ground water is recycled directly into CWP's wood preserving operations. In the wetter winter months, when a higher rate of ground water extraction can be achieved from Well HL-7, the extracted water that cannot be utilized in CWP's operations could be treated and discharged, provided the appropriate permits are obtained. Ground water can be treated using the existing electrochemical equipment at the site. The electrochemical treatment process produces effluent containing less than 0.05 mg/l of dissolved total chromium. The operation details of the electrochemical unit are provided in Section 7.2.4.

5.2.2 Treated Ground Water Disposal

As mentioned above, excess extracted ground water that cannot be recycled into wood preserving operations can be treated by electrochemical process equipment. CWP had planned to reinject the treated ground water into the water-bearing zone via an injection well, Well CWP-19, located to the west (hydraulically upgradient) of the retort area.

Well CWP-19 was installed in August 1985 in an open trench (IT Corporation, September 1985). The trench was excavated using a backhoe and is 25 feet long, 2.5 feet wide, and 24 feet deep. An 8-inch diameter, flush-threaded well casing was then installed approximately in the center of the trench. The well casing is perforated from 6 to 24 feet below grade. The trench was then backfilled with washed pea gravel and a surface seal of 5 feet of imported, medium-textured soil was placed and compacted.

According to CWP, Injection Well CWP-19 has not been effective in accepting large volumes of treated water, particularly during the wet, winter months when ground water levels are high. This is of concern as the volume of ground water extracted from Wells CWP-18 and HL-7 is highest during the winter months and, consequently, the volume of water to be disposed is also highest. After evaluating this method of disposal of treated ground water, injection was judged to be inappropriate during the winter months and high ground water level conditions. Under such conditions discharge in the Ukiah sanitary sewer system seems appropriate. During summer months, however, injection into Well CWP-19 may be a feasible alternative, if recycling is not possible or needed.

5.2.3 Observation Wells CWP-20 and CWP-21

On August 30, 1985, observation Wells CWP-20 and CWP-21 were installed at the north and south ends, respectively, of the slurry

cutoff wall. The locations of these wells are shown in Figure 2. The purpose of these wells was to enable an assessment of the effectiveness of extraction from Well HL-7 and the integrity of the slurry wall.

Wells CWP-20 and CWP-21 were installed in 8-inch diameter borings drilled to 23.0 and 22.0 feet, respectively. Both wells were completed with 2-inch diameter, flush-threaded PVC well casings, with 0.020-inch, machine cut slots. Well CWP-20 is perforated from 5 to 23 feet below grade and Well CWP-21 from 5 to 20 feet. Sand packs of No. 3 grade silica sand were installed to about the top of the perforated interval. The screened zones were then sealed with approximately 1 to 1.3 feet of bentonite pellets and grouted with concrete up to the ground surface.

The stratigraphy encountered during drilling indicates that neither well intercepts the more permeable Zone 2, although Well CWP-21 apparently intercepts a substantial gravel layer between 7.5 and 14 feet depth. Wells CWP-20 and CWP-21 were used as observation wells during evaluations of the effectiveness of the slurry wall and extraction trench.

5.2.4 Performance Evaluation

The performance of the slurry wall and extraction trench in containing the chromium plume and remediating the ground water has been assessed by evaluating ground water quality data and by a series of pumping tests.

Ground water quality data obtained since 1981 (Table B.2, Appendix B) demonstrate that the installation of the slurry cutoff wall and extraction of ground water from Well HL-7 have resulted in a reduction in chromium concentrations in wells located hydraulically downgradient of the slurry wall. The improvement in

ground water quality subsequent to 1983 has been discussed in Section 4.5.3. Therefore, these interim remedial measures are believed to have been effective in reducing off-site migration.

Two pumping tests were performed to evaluate the effectiveness of extraction from Well HL-7 in containing the chromium plume and to assess the integrity of the slurry cutoff wall. One test was performed in February 1986, and the other in July 1986 when water levels were low. The results of these tests demonstrated that extraction from Well HL-7 is effective in containing the plume near the southern end of the slurry wall where Well CWP-21 is located. The results were not conclusive in demonstrating that hydraulic containment of the plume is achieved near the northern end of the slurry wall. However, water quality data indicate that there is no plume migration in the zone intercepted by Well CWP-20 located at the north end of the slurry cutoff wall.

The details of the pumping tests have been presented in technical reports (Geosystem, March 1986; Geosystem, September 1986), copies of which have been submitted to the appropriate regulatory agencies.

5.3 RETORT AREA RECOVERY WELL

On August 29, 1985, a large diameter recovery well, CWP-18, was installed in the retort area at the location shown in Figure 2. Although the installation of this well has been previously reported (IT Corporation, September 25, 1985), a brief discussion is included for completeness.

Well CWP-18 was installed in a 36-inch diameter boring, advanced to a total depth of 14.0 feet and intercepting only Zone 1. An 8-inch diameter, flush-threaded well casing was installed. The casing is perforated from 5 to 14 feet below grade with 0.020-inch,

machine cut, slots. A sand pack of No. 3 grade silica sand was installed up to 6 feet below grade and sealed with 200 lbs of 0.25-inch bentonite pellets emplaced. The remaining annular space was concreted to the ground surface.

On February 13, 1986, a short duration pumping test was conducted (Geosystem, March 1986). Ground water levels at the CWP site were at or very near the seasonal high at this time of year. Water levels were measured in the pumping well and in nearby Monitoring Well CWP-6. The objective of this pumping test was to evaluate the maximum yield of Well CWP-18, and to estimate the hydrogeologic characteristics of Zone 1 in the retort area.

The pumping test demonstrated that Well CWP-18 can be effective in removing highly contaminated ground water from Zone 1 in the retort area. Extraction, however, must be at a low, continuous rate, on the order of 0.5 to 2.0 gpm, or by intermittent pumping at a higher discharge rate. During the dry season, when ground water levels in Zone 1 drop significantly, Well CWP-18 is expected to be less effective.

CWP-18 is not expected to contain the plume in the downgradient direction. However, this portion of the plume should be captured/contained by extraction from Well HL-7 and the slurry wall.

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6.0 RISK ASSESSMENT

The purpose of this assessment is to identify and assess the potential migration pathways and exposure mechanisms by which contaminants in soil and ground water in the study area may cause possible health risks and adverse environmental impacts. The *information presented in this section corresponds* to the requirements of Sections 5 and 6 of the RAP guidelines.

Systematic risk assessment includes site characterization, hazard identification, and fate analysis. The site has been characterized by a number of investigations, the results of which are summarized in Section 4.0. Hazard identification is performed by establishing the primary contaminants or indicator parameters and, based on available data, evaluating the level of hazard to human health and the environment. Chromium and arsenic have been selected as the indicator parameters based on their occurrence in soil and ground water, their geochemical behavior, and their toxicity. Accordingly, the risk assessment presented herein has been performed for these compounds. Fate analysis considers migration pathways in order to identify the potential exposure of contaminants to receptors.

Based on the above, the risk assessment includes an evaluation of potential migration pathways, documentation of toxicity, a description of the population potentially at risk, an exposure assessment, and a description of risk characteristics. The emphasis in this assessment has been placed on health rather than ecological impacts. Also, because of the zoning of the area, since the site after closure is expected to be used for industrial purposes, the results of risk assessment are believed to be applicable to post-closure conditions.

6.1 MIGRATION PATHWAYS

Potential migration pathways include airborne particulate matter and direct exposure to soil, surface water, and ground water. Each of these pathways is addressed below.

6.1.1 Migration Through Air

Potential sources of chromium, arsenic, and copper in the air include contaminated soil and CWP's wood preserving operations. Monitoring of air emissions from CWP's wood preserving process has been performed periodically; however, evaluation of the resulting air quality data is not within the scope of this RAP.

Contaminated soil exposed to the atmosphere may dry and soil particles can enter into the atmosphere as dust. Thus, chromium, arsenic, and copper could be carried by soil particles and dispersed into the atmosphere according to the prevailing climatic conditions. As pointed out in Section 5.1, however, essentially all areas where near-surface soils are known to contain elevated concentrations of chromium, arsenic, and copper have been paved. Therefore, there is not believed to be a significant potential for chromium, arsenic, and copper from on-site surface soils to migrate through air. Soils with background concentrations of chromium, arsenic, and copper in the study area could introduce these constituents into the atmosphere, but at insignificant levels.

No site-specific background air quality monitoring data are available; however, the concentrations of total chromium measured in ambient air in many urban and nonurban areas of the United States, from 1977 to 1980, have been documented (U.S. EPA, August 1984). The concentrations range from less than 0.0060 mg/m^3 to greater than 0.6000 mg/m^3. The mean chromium concentrations in nonurban, background areas such as national parks ranged from 0.0052 mg/m^3 to 0.0090 mg/m^3 over the 1977 to 1980 period. Selected

data, considered to be representative of the range of total chromium concentrations in air, have been summarized in Table 8.

In summary, under normal conditions, there is not believed to be a significant contribution of chromium, arsenic, and copper to the atmosphere through the residual contaminated soil at the site. Excavation and removal or other soil disturbance may, however, provide a potential air pathway. This pathway would require a detailed evaluation if excavation/removal were to be selected as a remedial alternative or if some other soil disturbance occurred. The evaluation would include air monitoring and comparison of the resulting data with background concentrations for hazard determination.

6.1.2 <u>Direct Exposure</u>

The most direct pathway for chromium, copper, and arsenic to impact human health and the environment is through contact with contaminated soil. As described in Section 5.1, the areas where near-surface soils are known to have been impacted are paved with asphalt or concrete. Direct exposure would be likely only if these soils were excavated or disturbed. Thus, such exposures would most likely occur during the closure of the plant and the subsequent remediation of the site.

According to tests performed on soil samples collected in the study area, the background concentrations of chromium, arsenic, and copper are less than 50, 14, and 20 mg/kg, respectively (Table D.1, Appendix D). For comparison, chromium concentrations in soils at selected locations in the United States are summarized in Table 9. The concentration of chromium in soil varies according to its origin. Comparing the chromium concentrations of surface soils at the CWP site with concentrations presented in Table 9, site

background concentrations are near the upper boundary of the range of median concentrations measured at the selected locations.

6.1.3 Migration Through Surface Water

Potential surface water migration pathways include sheet flow over the site and channel flow in the surface drains. Runoff from the site is collected in unlined ditches around the perimeter of the site. The ditches eventually discharge into the Russian River, also through unlined ditches. Surface runoff from the treated wood storage and retort areas is collected in a sump and recycled into CWP's wood preserving operations.

According to RWQCB staff, flow in the surface drains may be continuous during the winter months due to the inflow of ground water. Also, during periods of high precipitation, the water levels in the ditches rise to near the surrounding land surface. Observations made by CWP personnel indicate that intense precipitation results in flow in all surface drains surrounding the site. During light rainfall, however, storm water rapidly infiltrates into the valley fill through the unlined ditches and no flow is recorded at Station C-100 (Figure 2).

In accordance with RWQCB requirements, CWP personnel periodically monitor storm water quality during precipitation events of sufficient intensity and duration to cause flow in the ditches around the site. The results of storm water quality monitoring are presented in Appendix C. The highest recorded concentrations were 0.630 mg/l and 0.790 mg/l for Cr(VI) and total chromium, respectively, on March 13, 1984. Recent storm water quality data have indicated chromium concentrations to be at or below the drinking water standard of 0.05 mg/l on all but a few occasions. Recent storm water monitoring data for Monitoring Stations NE, NW, and C-100 show that concentrations of chromium and arsenic were

less than 0.02 and 0.004 mg/l, respectively, which are the detection limits for the compounds tested (Geosystem, April 1989). A summary of water quality criteria is presented in Table 10.

6.1.4 <u>Migration Through Ground Water</u>

The most probable pathway for chemical migration from the CWP site is via ground water. The most comprehensive data collected in January 1988 (Figure 14) indicate that elevated chromium concentrations are detected primarily on site, to the west and hydraulically upgradient of the slurry cutoff wall. The isoconcentration lines represent the areal extent of chromium contamination in the uppermost water-bearing zone, Zone 1. Because of the southeasterly flow direction, the dissolved chromium compounds have a tendency to migrate in the same direction, toward the slurry wall. The concentrations, however, decrease with distance from the retort area.

The rate of migration of chromium in on-site areas depends primarily on the seepage velocity of ground water and sorption characteristics of chromium. Previous analyses (IT Corporation, June 1985) have indicated that the migration rate of the chromium front at the site is about 58 feet per year. In this estimation, the lowest retardation factor, representing the lowest distribution coefficient, was used to provide a conservative analysis. A conservative analysis in this case is one resulting in larger migration rates and higher downgradient concentrations. The analysis is also conservative because ground water flow and chromium transport were assumed to be one-dimensional. Although the flow may be uniform and represented one-dimensionally, chromium transport is two-dimensional.

Hydraulic and ground water quality data, obtained from pumping tests and regular ground water monitoring, indicate that the

chromium front is intercepted by the slurry wall. Water impounded behind the slurry wall is then extracted via Well HL-7. It is noted that without some form of hydraulic control, in this case ground water extraction, impounded water would eventually flow around and beneath the slurry wall and chromium would continue to migrate in the downgradient direction. Construction of the slurry wall and extraction from Well HL-7 have substantially reduced dissolved chromium concentrations in off-site areas.

The presence of chromium in off-site areas is believed to have resulted primarily from migration prior to construction of the slurry wall in October 1983. Since then, the concentrations of chromium in off-site wells have gradually decreased, as discussed in Section 4.5.3. Ground water quality data from off-site wells, obtained in January 1988, show that chromium concentrations were below the drinking water standard of 0.05 mg/l. It is noted, however, that chromium concentrations in Well AT-2, located in the pear orchard, have occasionally exceeded the 0.05 mg/l drinking water standard.

The ground water quality data indicate that because of the overall site improvements and the interim remedial measures implemented, off-site migration is limited. To address potential off-site migration for risk assessment purposes, however, a two-dimensional areal model has been used. Details of this modeling effort are presented in Appendix E. The model has been used to predict the downgradient distribution of chromium under uniform flow conditions considering various management practices. The model results have shown the following:

- The predicted chromium concentrations are less than 0.05 mg/l at a distance of about 250 meters (820 feet) to the southeast of the slurry wall. This distance corresponds approximately to the location of Well AT-5. Chromium has not been detected in this well since its installation in December 1986.

- o The predicted chromium concentrations at other receptors beyond Well AT-5 are below the detection limit of 0.02 mg/l.
- o An increase in the chromium concentration in the assumed source area (near Well CWP-8) to about 1 mg/l for short durations will not result in chromium concentrations higher than 0.05 mg/l at the nearest receptor.

The model results indicate that fluctuations in chromium concentrations in the assumed source area (primarily Well CWP-8), within the range observed since slurry wall construction, will not result in chromium concentrations higher than drinking water standards in the nearby receptors. Off-site contamination is likely only if high chromium concentrations are allowed to migrate beyond the slurry wall and persist for a long duration. However, model simulations (Appendix E) have shown that if the concentrations of chromium at Well CWP-8 remain at about 1 mg/l for four years, downgradient concentration at about 820 feet from Well CWP-8 may approach 0.05 mg/l.

6.2 OCCURRENCE, INTAKE, AND TOXICITY CHARACTERISTICS OF CHROMIUM AND ARSENIC

Chromium, copper, and arsenic are elements which are found naturally in food, water, and air. Exposure of human beings to these elements at levels which exceed natural concentrations may lead to adverse health effects. Based on occurrence, concentrations, and relative toxicity effects, the evaluation presented herein pertains only to chromium and arsenic. Details related to occurrence, intake, and toxicity characteristics of chromium and arsenic are presented in Appendix F.

6.3 PUBLIC HEALTH AND POPULATION DENSITY

This section summarizes the information related to public health protection goals and population potentially at risk.

6.3.1 Public Health Protection Standards

Public health protection goals are established by public health and regulatory agencies. Recommended or established standards for chromium in the United States are summarized in Table 11. For protection of human health from the toxic properties of Cr(III), ingested through water and contaminated aquatic organisms, the ambient water criteria has been determined to be 170 ug/l. For protection of human health from the toxic properties of Cr(III) ingested through contaminated aquatic organisms alone, the ambient water criterion has been determined to be 3,433 ug/l. The ambient water quality criterion for total Cr(VI) is recommended to be identical to the existing drinking water standard which is 0.05 mg/l.

6.3.2 Population Potentially at Risk

Using population density statistics (Greater Ukiah Chamber of Commerce, June 1987) and the results of a survey and interviews by Geosystem personnel, the estimated number of people living in the study area within one-half mile from the CWP site varies seasonally from about 20 to 100. This population is potentially at risk in relation to surface water and ground water migration pathways. The population distribution around the site is addressed in more detail in Section 3.2.4.

6.4 EXPOSURE ASSESSMENT AND RISK CHARACTERIZATION

Based on the evaluation of potential migration pathways and the population potentially at risk, an exposure assessment has been performed and the risk associated with the exposure characterized.

6.4.1 Potential Exposure through Air

With maintenance of a cap or implementation of a permanent soil remedy, there is no significant exposure to chromium, arsenic, and

copper through air. Since there is no significant exposure, the risk of adverse health effects associated with migration of chromium through air is believed to be insignificant.

6.4.2 Potential Exposure through Direct Contact with Soil

As described in Section 6.1.2, because of surface paving over soils containing elevated chromium concentrations, there is no direct exposure to contaminated soil. Therefore, there is no risk of adverse health effects associated with this pathway under present conditions. However, during post-closure soil remediation, potential exposure is likely. Such exposure must be addressed by implementation of an appropriate health and safety plan.

6.4.3 Potential Exposure through Surface Water

Storm water runoff originating from the site is subject to infiltration and dilution by downstream flows. Potential exposure mechanisms, therefore, include exposure to ground water recharged by infiltrating surface waters and direct exposure to contaminated surface water. The first exposure mechanism is believed to be insignificant because of the intermittent nature of the runoff and attenuation of chromium and arsenic concentrations during downward percolation. The second exposure mechanism must consider the impact of dilution on chromium concentrations within the surface drainage ditches.

Site improvements and implementation of surface runoff control measures have reduced the concentration of chromium at the compliance point (Monitoring Station C-100) to acceptable levels (less than 0.05 mg/l). Additional surface water controls identified in Section 7.2.1 shall be implemented to further reduce the exposure through surface water. The most recent data have shown less than 0.02 mg/l and 0.004 mg/l concentrations for chromium and arsenic, respectively, at Station C-100. Under such

circumstances, the potential exposure of biological receptors in downstream ditches and streams is negligible.

Although no flow measurements have been made in the ditches downstream of the CWP site, based on field observations, an approximate dilution factor can be calculated. According to CWP, the flow rate at Monitoring Station C-100 is twice that at Station NE due to the contribution from other culverts and streams. As shown below, a comparison of water quality data between these two monitoring stations supports the above observation.

	CHROMIUM CONCENTRATION (mg/l)	
DATE	MONITORING STATION NE	MONITORING STATION C-100
April 6, 1986	0.14	0.09
March 5, 1987	0.06	0.03

The above data show that the chromium concentrations at Monitoring Station C-100 are about 50 percent of those detected at Monitoring Station NE. The distance between Monitoring Stations NE and C-100 is about 550 feet. It is evident that if flow rates increase at such proportions in the downstream direction and no chromium is introduced along the flow path, the chromium concentration will not exceed 0.05 mg/l within a short distance from Monitoring Station C-100, if waste discharge requirements are observed. Under such conditions, the impact of chromium on downstream receptors would be insignificant. To provide a more quantitative assessment of risk, flow rates must be known to estimate the dilution factors and the consequent potential impact.

The minimum flow in the Russian River is maintained at 150 cfs (DWR, May 1980). Under intense rainfall conditions, when storm

water flows to the Russian River, the volume originating from the site is assumed to be 1 percent of the flow in the river. With such an assumption, a dilution factor of 100 would be applicable for calculating the chromium concentrations in the river. Therefore, the storm water events, with historical concentrations of chromium, are not likely to have an adverse impact on surface water quality in the Russian River. A maximum concentration of 0.63 mg/l (Appendix C) at the site would result in a concentration of 0.0064 mg/l in the river. Thus, the risk associated with this potential exposure is insignificant.

6.4.4 Potential Exposure through Ground Water

Potential exposure through ground water has been evaluated considering on-site and off-site areas separately. Potential exposure to on-site ground water will only be possible during monitoring or activities related to ground water extraction and treatment. This exposure potential must be eliminated by following the appropriate health and safety measures and other standard procedures outlined in this RAP, the Storm Water/Ground Water Monitoring Protocol, and other pertinent documents. As there are no on-site wells producing water from the contaminated zone, there is no exposure and, thus, no risk.

As described in Section 4.5.3, the current understanding of off-site ground water quality conditions indicates that Cr(VI) concentrations are below the drinking water standard of 0.05 mg/l. No water-producing wells are known to exist in areas where historic chromium concentrations have exceeded the 0.05 mg/l drinking water standard. At the present time, therefore, there is not believed to be a significant potential for exposure through this migration pathway. This condition is expected to persist as long as on-site extraction from Well HL-7 and other remediation measures are in effect.

Failure to contain the chromium plume on site could result in the introduction of chromium to ground water immediately to the east (downgradient) of the slurry cutoff wall. The impact on downgradient receptors will depend on the concentration and persistence of the source, as demonstrated by the transport model (Appendix E). For instance, an initial concentration of 1 mg/l in ground water to the east of the slurry cutoff wall, with a source reduction rate of 0.0063 per day, would result in a concentration of less than 0.00068 mg/l at about 820 feet from the site. This concentration is about two orders of magnitude lower than the drinking water standard of 0.05 mg/l. However, persistence of the 1 mg/l concentration may result in gradual degradation of water quality in downgradient areas. As mentioned in Section 6.1.4, persistence of a 1 mg/l chromium concentration for four years at Well CWP-8 may cause an increase in chromium concentrations to 0.05 mg/l at a distance of 820 feet downgradient. To eliminate this potential situation, the recommended remedial action includes hydraulic control measures at Well CWP-8 (Section 7.0). Extraction from Well CWP-8 would contain the chromium plume in the vicinity and would eliminate the potential for further downgradient migration.

As mentioned in Section 7.0, a contingency plan has been developed for possible off-site remediation. The plan will be implemented subsequent to the regulatory agencies' decision regarding the criteria for initiation of off-site remediation. The criteria would include a prescribed chromium concentration persisting for a given time period. Implementation of the contingency plan will provide additional control to prevent further downgradient migration.

Based on the above considerations, it is concluded that under present conditions and with continued on-site remediation, there is no potential exposure to chromium through ground water. Therefore, there is no health risk associated with this pathway.

D R A F T

7.0 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

The purpose of evaluating various remedial actions is to select an environmentally acceptable and technically/economically feasible alternative for implementation. This evaluation considers viable remedial technologies to address soil and ground water contamination at the CWP site. The evaluation has been performed according to the procedure outlined by the EPA in a document entitled "Guidance on Feasibility Studies Under CERCLA" (U.S. EPA, June 1985b).

Section 7.1 presents an evaluation of the various remedial technologies considered. Those selected for implementation, based on technical, environmental, and cost considerations, are described in Section 7.2. The rationale for selecting the recommended alternative and rejecting the others is presented in Section 7.3. The environmental effects of the recommended alternative and the applicable laws and regulations are presented in Sections 7.4 and 7.5.

As described in Section 5.0, a number of interim remedial measures have been implemented in the course of the remedial investigations at the site. Therefore, in the evaluation of remedial action alternatives, the interim remedial actions already implemented have been considered.

7.1 ALTERNATIVE REMEDIAL ACTIONS

Remedial alternatives may be categorized as pertaining to source control or management of migration (U.S. EPA, June 1985a). For the CWP site, source control refers to the control of contaminated soil to reduce or prevent introduction of the contaminants to ground water. Management of migration refers to containment of the chromium plume and remediation of the impacted water-bearing zone.

The technologies evaluated to address soil and ground water contamination range from complete remediation to no action. The evaluation of viable options to address contaminated soil is presented in Section 7.1.1. Remediation of contaminated soils will occur at the time of closure of the facility. The closure of the facility is projected to be 10 years. A trust fund will be established (Section 9.0) to fund future remediation of soils. Treatability studies will be conducted prior to selecting the final soils remedy at the time of closure of the facility. The evaluation of the technologies available to address ground water contamination is presented in Section 7.1.2. As extraction is a viable option for the remediation of ground water contamination, alternative methods of ground water treatment have also been evaluated. This evaluation is presented in Section 7.1.3. The options for the discharge of treated ground water are evaluated in Section 7.1.4.

7.1.1 Control of Contaminated Soil

Previous investigations have delineated the areal extent of soils containing elevated concentrations of chromium and arsenic. Vertically, soils containing over 100 mg/kg of chromium and arsenic above background level (15 mg/kg) occur predominantly within the upper one foot of the soil profile. Most soil samples collected below a depth of 1 foot contain less than 50 mg/l of total chromium and arsenic concentrations in the range of background levels. More specifically, of the 25 soil samples collected from the 3-foot depth, only 5 contained more than 50 mg/kg of total chromium and none contained more than 100 mg/kg. The four 3-foot samples containing over 50 mg/kg were from Borings S-2, S-4, S-6, S-12, S-14, and S-23 which are spatially distributed across the site and do not indicate a single source such as the retorts on treated wood storage areas. In particular, it is noted that Boring S-23 is located off-site, across Taylor Drive. The distribution of

elevated total chromium concentrations, i.e. greater than 50 mg/kg, at depths of 6 and 10 feet below grade is similar to that described above at the 3-foot depth. Accordingly, the areal distribution of total chromium is best represented by isoconcentrations at the one-foot depth. The approximate distribution of soils containing over 100 mg/kg of chromium at the one-foot depth is shown in Figure 11. This delineation of chromium distribution and other pertinent remedial investigation findings (Section 4.0) have been used as a basis for developing and evaluating various remedial technologies. The potential remedial technologies considered for control of the contaminated soil include:

- o Soil removal and off-site disposal.
- o Soil removal and on-site treatment.
- o In-situ treatment.
- o Partial excavation.
- o Containment.
- o No action.

7.1.1.1 <u>Soil Removal and Off-Site Disposal</u>

This technology considers removal and off-site disposal of soil in which the chromium concentration is above 100 mg/kg and arsenic concentrations above 16 mg/kg. The concentration for chromium has been selected on the basis of the previous soil quality characterization which demonstrated that 100 mg/l may be considered to be definitely above background levels. Based on the 100 mg/kg total chromium isoconcentration shown in Figure 11, the area of concern is estimated to be about 69,800 ft.^{2} or 1.60 acres. To estimate the volume of contaminated soil, it has been assumed that the soil is uniformly contaminated to an average depth of 1.5 feet below grade. Based on this assumption, the volume of contaminated soil would be approximately 3,880 cubic yards. It should be noted that in certain areas, such as the main process area, the depth of contamination may be greater. Accordingly, in the absence of any other data, it has been assumed that the area beneath the retorts

and the rail lines, measuring about 50 feet by 280 feet, is contaminated at greater than 100 mg/kg total chromium and greater than 15 mg/kg arsenic to an average depth of 5 feet below grade. The additional volume within this arbitrary zone is 1,890 cubic yards. The estimated total volume of soil containing 100 mg/kg or more of total chromium is estimated to be 5,770 cubic yards.

Typically, soil excavation to a depth of 1 to 2 feet would be performed by dozers and the soil loaded onto trucks and transported to a licensed hazardous waste facility approved by EPA and in accordance with applicable SARA requirements. The nearest operating facility to the site is in Kettleman City, located in central California.

Complete removal of contaminated soil, to the limits shown in Figure 11, would require the cessation of wood preserving operations and the removal of the wood preserving facilities. Therefore, it has been assumed that any such remediation would occur subsequent to the closure of the CWP operation. The estimated cost for removal and off-site disposal of 5,770 cubic yards of soil is presented in Table 12.

7.1.1.2 Soil Removal and On-Site Treatment

This alternative includes excavation and removal of soil, followed by on-site treatment. On-site treatment may involve the use of organic or inorganic polymers which have the capability of binding the metals, making them less susceptible to leaching. These technologies have not been tested at field scale; thus, it is not known how applicable they may be to the CWP site. To realistically evaluate on-site treatment as a remedial option for contaminated soil, laboratory and field tests are needed. Normally, a number of products are tested to assess their fixation potential. The fixation potential is determined by evaluating the leaching

behavior of the soil prior to and after treatment. If laboratory tests indicate that a particular treatment is acceptable in terms of leaching, a pilot test is generally performed to assess the applicability of the technology to field conditions. If the pilot test demonstrates that the method is applicable to field-scale remediation, a detailed design is prepared. Geosystem's experience in similar projects shows that on-site treatment is feasible.

For cost estimating purposes, it has been assumed that on-site treatment is a feasible remedial option. It is noted, however, that despite the avoidance of the high cost of off-site disposal, the estimated cost of on-site treatment is still relatively high. This is due primarily to the duration of implementation. The estimated costs associated with excavation and on-site treatment are shown in Table 12.

7.1.1.3 <u>In-Situ Treatment</u>

This option includes in-situ physical and/or chemical treatment to fix the chromium and arsenic in soil to the extent that it would not act as a source to ground water contamination. The simplest in-situ treatment method would be leaching the soil with water and extracting and treating the leachate. If this method were chosen, the pavement would have to be removed to allow water to percolate through the contaminated soil and leach the chromium.

Previous laboratory leachability studies (D'Appolonia/IT, May 1984) have shown that under acidic conditions (pH = 5.0), a maximum of 2.8 percent chromium is recoverable. These results have also indicated that most of the chromium in the soil is in the Cr(III) form. The trivalent forms of chromium are more stable, less soluble, and less mobile than the hexavalent forms. Therefore, if in-situ leaching was performed with a neutral pH solution (water), lower chromium recovery would be expected. Considering the leaching characteristics of trivalent chromium and operational

constraints, in-situ leaching does not appear to be an efficient means of remediation.

Other options include injection of compounds into the soil to chemically fix the chromium and arsenic in soil. This option is generally more effective in homogeneous, saturated aquifer systems of high permeability. Given the complex stratigraphy and discontinuity of permeable strata at the site, this type of in-situ treatment is judged to be ineffective and has not been considered further.

7.1.1.4 Partial Excavation and Off-site Disposal

Partial excavation is another viable alternative to control contaminated soil at the site. Based on previous site investigations, the areas of soil containing more than 130 mg/kg of chromium and 15 mg/kg of arsenic have been identified (Figure 3, IT Corporation, 1985; Figure 11). These areas center around Borings S-4, S-5 and S-8 and sampling locations G-5, G-10, and G-11. The locations of these borings and sampling locations are shown in Figure 11. The 130 mg/kg level Cr concentration was chosen because it enabled areas within the 100 mg/kg soil contamination boundary to be addressed without complete soil removal. It is noted that the areal extent of arsenic contamination generally coincides with that of chromium (Figure 11). Based on a depth of contamination of 2 feet, partial excavation would result in an estimated soil volume of about 1,300 cubic yards. The estimated costs associated with implementation of this option are summarized in Table 12.

7.1.1.5 Containment

The simplest method of containment is to provide surface paving over the areas known to contain greater than 100 mg/kg of chromium and 15 mg/kg of arsenic. The surface paving or capping would prevent infiltration of surface water through the contaminated soil

and consequently minimize or eliminate the leaching of chromium into ground water. Surface paving has been installed at the site in various phases since 1979. The present extent of surface paving is shown in Figure 2. Comparison with the area of near-surface soil contamination demonstrates that the large majority of chromium-containing soils are located beneath the paved area. Maintenance of the integrity of the existing cap is an essential component of effective containment prior to implementation of a permanent remedy. ~~Approximately 3 percent of the contaminated soil area is not currently paved~~. Recommendations concerning these remaining unpaved areas are presented in Section 7.2.

Other methods of containment include physical barriers, such as slurry, sheet pile, or chemical grout cutoff walls; or hydraulic barriers, such as extraction/injection systems. These options are addressed further in relation to plume control in Section 7.1.2.

7.1.1.6 <u>No Action</u>

This option allows the contaminated soil to remain in place, unremediated. Implementation of the no action option is typically combined with other control measures if ground water contamination is of concern. Also, the no action option requires extensive monitoring to evaluate the potential impacts of residual soil contamination on the environment. Ground water monitoring data, generated since 1981, have indicated some improvement in water quality, primarily in off-site areas. Application of the no action alternative to the entire site would, however, require further evaluation of the potential impact on ground water quality and the environment, as described in Section 7.3.

7.1.2 <u>Plume Control</u>

Plume control measures would be designed to limit the migration of the dissolved constituents while gradually remediating existing

contamination. The alternatives considered for screening are as follows: (see table 17)

- o Physical containment.
- o In-situ treatment.
- o Hydraulic control.
- o Electrokinetic phenomena.
- o No action.

7.1.2.1 Physical Containment

Physical containment measures include slurry cutoff walls, sheet piles, and grout curtains. The most common method of physical containment for plume control is the construction of slurry cutoff walls. This option, per se, does not remediate the aquifer; however, the contaminants are contained. A slurry cutoff wall is constructed by excavating a continuous, narrow trench which is kept filled with bentonite slurry to stabilize the sides of the excavation. The trench is backfilled with a mixture of excavated soil and bentonite as trenching progresses. Backfilling displaces the slurry, which is recycled. The slurry wall acts as a barrier to lateral ground water flow if the zone of contamination is completely contained. Otherwise, hydraulic control must be initiated to provide adequate containment. Flow beneath the wall is restricted by either keying the wall into a low permeability stratum or by hydraulic control. As discussed in Section 5.2, this option has been implemented as an interim remedial measure by CWP. Other physical containment measures, such as sheet piles and grout curtains, have not, therefore, been considered further.

7.1.2.2 In-Situ Treatment

This technology involves the passage of a treatment agent through the contaminated aquifer, usually by pumping and/or injection. The effectiveness of this option depends primarily on the permeability of the contaminated medium, the continuity of the water-bearing zone, and the degree of bonding of chromium to soil

particles. In-situ treatment by this method is not a proven technology, particularly if considered for application to chromium fixation in large areas. Research related to application of this technology is underway, and if future data show promising results, its application to the CWP site could be reconsidered. At this time, however, in-situ treatment by chemical fixation has not been considered further.

7.1.2.3 Hydraulic Control

Hydraulic control is an accepted and well documented method of plume control and aquifer remediation. This option includes extraction and/or injection in order to produce a zone of influence beyond which there will not be significant migration of contaminants. Extracted ground water is replenished by contaminant-free ground water, resulting in a gradual reduction in chromium concentrations.

Considering the chromium isoconcentrations shown in Figures 12, 13, and 14, the application of hydraulic control is believed to be relevant to the following geographic areas:

- Near the retorts
- Near the eastern site boundary
- Off site to the southeast.

The ground water quality data have shown that chromium concentrations are higher in Zone 1 in the retort area than in other locations. To prevent chromium migration from the retort area to downgradient locations, interception of the plume by trenches or large diameter recovery wells has been considered. Both of these methods could provide a barrier to chromium migration within their respective radii of influence. Trenches are typically more effective in water-bearing zones which are not very conductive and lack hydraulic continuity; however, the presence of wood

preserving facilities in the retort area precludes the installation of a trench. As described in Section 5.3, a large diameter recovery well, Well CWP-18, was installed near the retort area as an interim remedial measure.

Plume control near the eastern site boundary has also been considered in order to prevent off-site migration. As described in Section 5.2, this option includes extraction from Well HL-7 and has been implemented as an interim remedial measure. In addition to extraction from Well HL-7, pumping from the downgradient side of the slurry wall would contain any contamination which may have passed the barrier and acts as a source of off-site contamination.

Off-site remediation has been considered because of the presence of chromium in some off-site wells in the past. Off-site remediation has been evaluated in some detail (Geosystem, April 1987) and is not believed to be necessary at this time. This judgement is based on current ground water quality and the trend of improving water quality in off-site areas as a result of the interim remedial measures implemented near the eastern site boundary. It should be noted, however, that future monitoring and new regulations may dictate reconsideration of off-site remediation.

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Hydraulic control measures which involve the extraction of contaminated ground water require an environmentally acceptable and cost effective method of handling the extracted water. As previously mentioned, the majority of the extracted chromium-containing water is recycled back into CWP's wood preserving operation; therefore, no special handling is required. Excess contaminated water must, however, be treated prior to discharge. Section 7.1.3 summarizes the alternative treatment processes considered to achieve acceptable effluent quality.

7.1.2.4 Electrokinetic Phenomena

Electrokinetic phenomena refers to those methods by which migration of dissolved contaminants in ground water is enhanced by the application of an electric current. The methodology is based on inducing electrical gradients to the soil-electrolyte-water system, resulting in displacement or migration of cations and anions. Historically, this technology has achieved some degree of success in inducing flow in low permeability dispersive soils. Application of this method to the removal of inorganic species and dewatering has been demonstrated by a number of investigations (Mitchell and Arulanandan, 1968; Gray and Mitchell, 1967; Mehran, 1971). Recently, the EPA has initiated a number of projects to test the applicability of this technology to field-scale problems. As this technology is still in the developmental stage, however, it has not been considered further for implementation at the CWP site.

7.1.2.5 No Action

This option allows the dissolved contaminants to migrate uncontrolled and unremediated. This option would result in an expansion of the plume in the downgradient direction and would place potential biological receptors at risk.

7.1.3 Ground Water Treatment Technology Assessment

As mentioned in Section 5.0, CWP is able to utilize extracted ground water in wood preserving operations at certain times of the year. When the supply of extracted ground water exceeds CWP's needs, however, treatment is required before discharge.

The evaluation of the various ground water treatment technologies is based on a continuous extraction rate of 5 to 20 gpm for seven years, a chromium concentration of less than 10 mg/l in the influent, and a required effluent concentration of less than 0.05 mg/l.

The treatment technologies have been screened on the basis of the following technical and economic criteria:

- o Performance and effectiveness of the technology.
- o Projected service life.
- o Demonstrated reliability.
- o Ease of implementation.
- o Safety considerations.
- o Capital costs.
- o Operation and maintenance costs.

The operation and maintenance (O&M) costs are those post-construction costs necessary to maintain satisfactory operation of the treatment system and the required monitoring (Table 13).

The objective of the screening was to eliminate those technologies that have an order of magnitude greater cost, but do not provide greater environmental or public health benefits or greater reliability. The technologies considered for screening were:

- o Electrochemical process.
- o Chemical reduction and precipitation.
- o Chemical precipitation with sedimentation or filtration.
- o Activated carbon adsorption.
- o Ion exchange.
- o Reverse osmosis
- o Electrodialysis.

7.1.3.1 <u>Electrochemical Process</u>

The electrochemical process involves passing chromium-containing ground water through a cell containing consumable iron electrodes which, in the presence of an electrical current, generate ferrous

and hydroxide ions. These ions react with chromate ions in solution to precipitate chromic and ferric hydroxides. This process is unique in that no chemical additives are required to generate the precipitant. The electrochemical operation is a "once-through process" requiring minimal reaction time. The theory of operation involves an oxidation-reduction reaction whereby electrons are supplied by an external electrical source reducing the metal ions in the electrolyte to form elemental metal at the cathode surface. The equipment consists of a reactor module containing the anode and cathode assemblies and two controllable power supplies. The details of this technology related to electrode potentials, equilibrium, oxidation-reduction, and mixed potentials, voltammetry, and electrocapillarity capacity have been described in the literature (Ahmed, 1979; Pemsler and Rappas, 1979; Ayres and Fedkiw, 1983; and Dean et al., 1972). More specific information on operation of electrochemical process units is presented in Section 7.2.4.

Electrochemical treatment has been used for many years in the mining and utility industries and is a proven technology for removing hexavalent chromium from wastewater. The electrochemical treatment process, therefore, is capable of removing hexavalent chromium from ground water extracted at the CWP site (Table 14).

The advantages of the electrochemical process are as follows:

- Reduces the Cr(VI) content of ground water to EPA compatible levels.
- Very low operating costs.
- No consumable reagents required for operation.
- Requires little floor space and operator attention.
- Eliminates the conventional chemical precipitation process.

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The operating costs for electrode consumption, power, and acid for the electrochemical unit are estimated at about 10 cents per 1,000 gallons of ground water treated. At the anticipated flow rate of 20 gpm, the operating costs amount to about $1,000 annually. Labor and waste disposal costs for the electrochemical process are estimated to be about $50 per day.

7.1.3.2 <u>Chemical Reduction and Precipitation</u>

The most conventional method for the removal of chromium is reduction of the hexavalent chromium to the trivalent state, followed by pH adjustment to form insoluble carbonates or hydroxides which can be removed as sludges. Some common reducing agents include gaseous sulfur dioxide, sodium bisulfite or metabisulfite, and ferrous sulfate. In the reduction of hexavalent chromium to trivalent chromium using sulfur dioxide, the oxidation state of chromium changes from 6^+ to 3^+ (Cr is reduced) and the oxidization state of sulfur increases from 2^+ to 3^+ (S is oxidized).

$$2H_2CrO_4 + 3SO_2 + 3H_2O \longrightarrow Cr_2(SO_4)_3 + 5H_2O$$

Sulfur dioxide is supplied as a gas and fed into the chrome reduction tank as liquid through a vacuum eductor-type of sulfonator. The sulfonator is controlled by an oxidation reduction potential (ORP) probe measuring free sulfides in the chrome reduction tank. Mixing is usually required to improve contact between the reduction agent and the ground water. Reaction times vary with reducing agents, temperature, pH, and concentration; however, reduction times are on the order of minutes.

Reduction of hexavalent chromium requires pH adjustment, normally with sulfuric acid, to a pH of approximately 2 to 3. When sulfur dioxide is used as the reducing agent, sulfonators must be used to combine sulfur dioxide with water to form sulfurous acid. The

sulfurous acid reacts with chromium to form chromic sulfate. Other reducing agents are added as solids or as solutions. The chemical reduction is followed by alkaline addition, which results in precipitation of chromium hydroxide.

Chemical reduction followed by precipitation requires several process steps, consumes chemical additives for pH adjustment and the reduction reaction, and generates a sludge that must be disposed of. An automated system could be provided to carry out these operations; however, some operator attention would be required. Chemical reduction can be carried out using simple, readily available equipment and reagents.

Chemical reduction is used primarily for the reduction of hexavalent chromium, mercury, and lead and is a well tested and documented method of treatment for these metals. Due to its documented applicability, laboratory and pilot-scale tests may not be required to determine appropriate chemical feed rates and reactor retention time for the reduction of hexavalent chromium to trivalent chromium at the CWP site.

The total capital costs for chemical reduction, including the costs for chemical storage, feeding, and mixing, were estimated to be $224,000 with a total annual O&M cost of $192,000 (U.S. EPA, 1978). These cost estimates are based on a 20 gpm system using the 1987 ENR Construction Cost Index.

7.1.3.3 <u>Chemical Precipitation with Sedimentation or Filtration</u>
This technology involves the addition of chemicals to an aqueous solution to combine dispersed particles into larger agglomerates which are removed during the precipitation (settling) process. Precipitation is a physicochemical process whereby some or all of a substance in solution is transformed into a solid phase.

Generally, lime or sodium sulfide is added to the ground water in a rapid mixing tank. The water flows to a flocculation chamber in which adequate mixing and retention time is provided for agglomeration of precipitation particles by adding an agent such as alum. Agglomerated particles are separated from the liquid phase by settling in a sedimentation chamber and/or by other physical processes such as filtration.

Precipitation is applicable to the removal of most metals from wastewater including zinc, cadmium, chromium, copper, fluoride, lead, manganese, and mercury. Cyanide and other ions in the wastewater may also complex with metals, making treatment by precipitation less efficient. Precipitation is non-selective in that compounds other than those targeted may be removed. Both precipitation and flocculation are nondestructive and generate a large volume of sludge which must be disposed. The technology is, however, considered to be potentially applicable to the treatment of chromium-containing ground water at the CWP site.

Precipitation and flocculation pose minimal health and safety hazards to field workers. The entire system is operated at near ambient conditions, eliminating the danger of high pressure/high temperature operation. While the chemicals employed are often skin irritants, they can be handled in a safe manner.

Arumugam (1976) studied hydroxide precipitation for the recovery of chromium from spent tan liquor. This precipitation process was the least expensive method for the removal and recovery of chromium. Using lime and at an optimum pH of 6.6, the removal of chromium exceeded 98 percent. The precipitated chromium hydroxide is separated by settling, filtered, and redissolved in sulfuric acid to form chromium sulfate which can be recycled for further tanning. The use of lime was more economical than the use of other

alkalines (NaoH, Na_2Co_3, and NH_4oH). The use of lime softening and coagulation using alum for removal of such heavy metals as Cr(III) and Cr(VI) have been investigated by the EPA (U.S. EPA, 1978).

For a 20 gpm chromium removal system, the equipment cost is estimated to be $50,000 (EPA/625/6-85/006, updated to 1987 using the ENR Construction Cost Index). A total chemical cost of $4.80 per 1,000 gallons is estimated for this precipitation process to achieve an effluent containing less than 0.05 mg/l of chromium. The annual O&M cost is estimated to be $64,000 with a total capital cost of $192,000.

7.1.3.4 <u>Activated Carbon Adsorption</u>
Chromates can be effectively removed from ground water by passing the chromate-containing ground water through a column packed with activated carbon (Yoshida et al., 1977). Huang and Wu (1975) found that the removal of Cr(VI) by calcinated charcoal was most significant at low pH and for low initial Cr(VI) concentrations. Landrigan and Hallowell (1975) demonstrated that activated carbon could be used by small plating facilities for removal of chromium. Huang and Wu (1975) studied the effect of pH on Cr(III) and Cr(VI) adsorption by Filtrasorb 400 activated carbon. Cr(VI) was at least twice as adsorbable as Cr(III). The optimum pH for adsorptive removal was 5.5 to 6.0 for Cr(VI) and 5.0 for Cr(III).

Granular activated carbon (GAC) is usually preferred since it can be chemically regenerated and reused. Powdered activated carbon (PAC) is less expensive, but it can only be used on a once-through basis.

Activated carbon will adsorb hexavalent chromium and many metals complexed in organic form. The adsorptive capacity depends on the carbon pore size, solution pH, and the initial and final

concentration of the metal(s). Activated carbon adsorption is considered to be an applicable technology for the removal of Cr(VI) from ground water at the CWP site. In particular, activated carbon adsorption shows considerable promise for removing low concentrations of chromium (in the range of 1 to 2 mg/l) remaining after other treatment methods such as precipitation, cementation, etc. Regeneration of the spent carbon is possible with the use of caustic solution.

There are a number of operational considerations, however, that make carbon adsorption an inappropriate choice as a treatment option for ground water containing Cr(VI), as discussed below:

- On the carbon surface, Cr(VI) is partially reduced to Cr(III) which does not adsorb well on carbon.
- The maximum adsorption of Cr(VI) occurs at a pH of approximately 2.5. At lower pH values, the Cr(VI) is reduced to Cr(III); at higher pH values, the adsorption of Cr(VI) decreases rapidly.
- Cr(VI) can be stripped from the carbon with a caustic solution. Removal of Cr(VI) can then be accomplished by chemical addition and pH adjustment in a mixing vessel; however, a chromium contaminated sludge is generated.

A carbon adsorption system with caustic regeneration could be designed to remove Cr(VI) from ground water at the CWP site, but Cr(III) would not be removed by this method. Although it is true that higher concentrations of Cr(III) in the effluent can be tolerated, for certain methods of treated water discharge, lower concentrations of Cr(III) are advantageous. Certain equipment and chemicals are needed to carry out pH adjustment of the ground water and in the adsorption operation.

Typical capital and O&M costs are presented in Table 13. Additional equipment, controls, and chemicals would be required

for carbon regeneration, which is preferred over a nonregeneration approach, to minimize the cost of carbon replacement and contaminated carbon disposal. However, even with the use of carbon regeneration, disposal of chromium contaminated sludge and some spent carbon would be necessary. For the reasons stated above, carbon adsorption would not be a cost effective option for the removal of chromium from ground water at the CWP site.

7.1.3.5 Ion Exchange

The ion exchange process for chromium removal is similar in operation to the carbon adsorption system discussed in Section 7.1.3.4. Wastewater is passed through a bed of ion exchange resin, which contains active ionic functional groups. Chromium ions are exchanged and removed from the resin and then separated by pH adjustment and precipitation. Ion exchange is a process whereby the mobile ions are removed from the ground water phase by being exchanged with relatively immobile ions held by the ion exchange matrix (Weber, 1972). The removal of chromium depends primarily on the valence of the chromium ion, the type of resin, and the chromium concentration in ground water. The chromate-dichromate pair of divalent anions presents a different case. In alkaline solutions, hexavalent chromium exists in solution as the chromate ion CrO_4^{2-}. As pH drops below 6, chromate ions condense to form dichromate ions $Cr_2O_7^{2-}$. Both ions appear to be held selectively over common monovalent anions.

$$\overline{(R_4N^+)_2},\ \overline{Cr_2O_7^{2-}} + 2NaOH \longrightarrow \overline{(R_4N^+)_2},\ \overline{CrO_4^{2-}} + Na_2CrO_4 + H_2O$$

This reversibility is used in removing hexavalent chromium from ground water.

Ground water enters the top of the resin column under pressure, passes downward through the resin bed, and is removed at the

bottom. When the resin capacity is exhausted, the column is backwashed to remove trapped solids and then regenerated. Suspended solids in the feed stream should be less than 50 mg/l to prevent plugging the resins. The cationic exchange resin is regenerated with a strong acid, such as sulfuric acid or hydrochloric acid. Sodium hydroxide is a commonly used regenerant for anion exchange resin. This process can take place in separate exchange columns arranged in series, or both resins can be mixed in a single reactor (Elzel and Tseng, 1984).

For the reduction of Cr(VI) and Cr(III), both anionic and cationic exchange resins must be used. The ground water is first passed through a cation exchanger where the positively charged ions, such as Cr(VI), are replaced by hydrogen ions. The cation exchanger effluent is then passed over an anionic exchange resin where the anions are replaced by hydroxide ions. Thus, the chromium ions are replaced by hydrogen and hydroxide ions that react to form water molecules.

Hexavalent chromium can be successfully recovered using ion exchange treatment. Because of factors such as resin capacity and the number of times the resin can be regenerated, this technology

is usually applicable only to those situations involving relatively low influent concentrations. Removal efficiencies of 90 to 99 percent have been reported for the treatment of ground water with a conventional two-stage exchanger system. Even higher removals are possible with mixed bed exchangers.

The unit volume cost for strong-base resins is 3 to 4 times that of strong-acid resins. The higher cost of strong-base resins is due to the considerably more complex manufacturing process required for the anion resins.

The advantages of the ion exchange process are:

- o Simple, basic type of unit with easy maintenance.
- o Better quality control due to elimination of process variability.
- o Reduced waste disposal costs.

Ion exchange has similar disadvantages to carbon adsorption for application to the treatment of ground water from the CWP site. Specifically, the ion exchange, regeneration, and chromium precipitation operations require a variety of equipment, controls, chemicals, and labor. These items result in high capital and operational costs. Included in these expenses is the high cost of ion exchange resin. If both Cr(VI) and Cr(III) are present in the wastewater, two resin beds would be required because Cr(VI) absorbs on anion resin (Cr^{+6} existing as CrO_4^{-2}) and Cr(III) absorbs on cation resin. Regeneration and precipitation of chromium would also be further complicated if both Cr(III) and Cr(VI) are present in the ground water.

The major disadvantages of this technology are as follows:

- o High regeneration cost.
- o Fluctuating effluent quality.
- o Requires substantial floor space.

The construction cost for a system capable of handling 20 gpm, including a steel contact vessel, a resin depth of 6 feet, housing for the columns, and all piping and backwash facilities, is estimated to be $84,000 with an O&M cost of $14,000. The O&M cost includes electricity for backwashing and periodic repair and replacement costs. Costs for regenerant chemicals are not included because they vary depending on the concentrations of chromium to be removed from the ground water.

7.1.3.6 Reverse Osmosis

If a pressure equal to or greater than the osmotic pressure is applied to the solution side of a membrane, the solvent will flow across the membrane leaving a more concentrated solution. This process is known as reverse osmosis. Sufficiently high pressure, usually in the range of 200 to 400 psi, will force the solvent out of solution, producing a more concentrated stream which must be treated further or disposed of. Ions and small molecules in ground water can be separated from water by this technique. The concentrated waste stream requires additional treatment to remove or recover the chromium.

The basic components of a reverse osmosis unit are the membrane, a membrane support structure, a containing vessel, and a high pressure pump. The membrane and membrane support structure are the most critical elements. The fact that reverse osmosis units can be operated in series or in parallel provides some flexibility in dealing with increased flow rates or concentrations of dissolved species.

Available information and experience is limited regarding the use of reverse osmosis for ground water treatment. A hexavalent chromium removal efficiency of 93.5 percent has been reported for an influent concentration of 49.6 mg/l (Hindin, 1968). The volume of the reject generated by reverse osmosis is about 10 to 25 percent of the feed volume. Provisions must be made to treat this potentially hazardous waste. Pretreatment of the secondary effluent with filtration and carbon adsorption is usually necessary.

A very high quality feed is required for efficient operation of a reverse osmosis unit. The removal of iron and manganese is also necessary to decrease scaling potential. The pH of the feed should

be adjusted to a range of 4.0 to 7.5 to inhibit scale formation. The primary limitations of reverse osmosis are its high cost and the problem of a concentrated waste stream which must be treated further using another technology. Because of the low removal efficiency and high quality feed requirements, reverse osmosis is not considered to be applicable to the treatment of ground water at the CWP site.

The total capital cost, including housing, tanks, piping, membranes, flow meters, cartridge filters, acid and polyphosphate feed equipment, and cleanup equipment, to treat 20 gpm are estimated to be $400,000 with a total annual O&M cost of $150,000. The O&M costs include electricity for the high pressure feed pumps (450 psi operating pressure), building utilities, routine periodic repair, routine cleaning, and membrane replacement every three years (EPA 600-8-80-042d).

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7.1.3.7 Electrodialysis

In the electrodialysis process, ionic components of a solution, such as Cr(VI), are separated through the use of semi-permeable, ion-selective membranes. Application of an electrical potential between the two electrodes causes electric current to pass through the solution, which, in turn, causes a migration of cations toward the negative electrode and a migration of anions toward the positive electrode. Because of the alternate spacing of cation and anion permeable membranes, cells of concentrated and dilute solution, are formed (Poon and Lu, 1981).

Ground water is pumped through the membranes which are separated by spacers and assembled into stages. The retention time in each stage is usually about 10 to 20 seconds. Removal of chromium from ground water varies with:

- o Ground water temperature;
- o Amounts of electrical current passed;
- o Amount of Cr(VI) and/or Cr(III) ions;
- o Fouling and scaling potential;
- o Number and configuration of stages.

This process may be operated in either a continuous or a batch mode. The units can be arranged either in parallel to provide the necessary hydraulic capacity or in series to achieve the desired degree of chromium removal. Makeup water, usually about 10 percent of the feed volume, is required to wash the membranes continuously. A portion of the concentrate stream is recycled to maintain nearly equal flow rates and pressures on both sides of each membrane. Sulfuric acid is fed to the concentrate stream to maintain a low pH and, thus, minimize scaling.

To achieve high throughput, electrodialysis cells in practice are made very thin and assembled in stacks of cells in series. Each stack of 10 consists of more than 100 cells. Generally, electrodialysis works best on acidic streams containing a single principal metal ion.

An electrodialysis plant produces two product streams, one dilute and one concentrated, which may need to be disposed or further treated. Because of hydrogen generation, this technology may cause some local air pollution (EPA 600-8-80-042c).

Electrodialysis has the advantage of being a continuous process which, unlike the adsorption process, does not require regeneration. However, electrodialysis is usually not economical for treatment of very dilute chromium solutions like the CWP ground water and for situations where low effluent concentrations are required. A more common application for this technology is the recovery of ionized species such as metal salts, cyanides, or

chromates from metal finishing wastewaters, which are at considerably higher concentrations than the CWP ground water.

Problems associated with the electrodialysis process include chemical precipitation on the membrane surface and clogging of the membrane by the residual colloidal organic matter in ground water. To reduce membrane fouling, activated carbon pretreatment, possibly preceded by chemical precipitation and some form of multimedia filtration, may be required. This process may, therefore, require more attention and maintenance than other systems discussed in previous sections. Also, this process is not an established technology for the subject application. It is still considered to be possibly applicable to the treatment of ground water at the CWP site.

The capital cost associated with this option is approximately $85,000. The O&M costs are estimated at $1.00 per 1,000 gallons.

7.1.4 <u>Alternatives for Discharge of Extracted Water</u>

Ground water extraction for plume control and remediation requires an appropriate means of handling the pumped water. The options considered for handling extracted ground water, either with or without treatment, are as follows:

- Recycling.
- Sanitary sewer discharge.
- Surface water discharge.
- Subsurface injection.

7.1.4.1 <u>Recycling</u>

The most cost-effective method of handling the contaminated water is to recycle the pumped water into CWP operations without treatment. This would be possible so long as CWP's demand was larger than the volume extracted. Otherwise, partial recycling combined with treatment/disposal of the balance could be performed.

To explore the possibility of recycling, a review of the water balance is necessary. The total surface water collection area is 22,840 ft^2. Thus, one inch of rain generates 14,180 gallons of runoff. The storm events of interest and the corresponding volume of water are as follows (Department of Water Resources, 1976):

STORM EVENT	RAINFALL (inches)	VOLUME OF WATER (gallons)
10-year winter	48.93	693,827
100-year/24-hour	6.66	94,439

The CWP operation uses 20 above-ground tanks with a total storage capacity of 752,000 gallons. Assuming the occurrence of a 10-year winter storm, the available storage will amount to 59,173 gallons (752,000 minus 693,827). The daily operational use is about 8,000 gallons or approximately 5.5 gpm. Therefore, if the extraction system operates at about 5 gpm during dry conditions, all the extracted water can be recycled. Also, during the storm events (10-year winter), extraction rates of 4 to 6 gpm could be accommodated for about 8 days utilizing the available storage.

It is evident from the mass balance calculations that for extraction rates greater than 5 gpm or during the wet winter months, an additional discharge option is required. It is important to note that higher extraction rates are desired during the wet season to achieve a greater degree of migration control and remediation.

7.1.4.2 Discharge into the Sanitary Sewer

Discharge of treated ground water into the sanitary sewer is a viable option which is currently being pursued by CWP. This option has been under consideration since 1983, when the City of Ukiah (the City) informed CWP of the regulations concerning the criteria

for discharging wastewaters into the sanitary sewer system. Upon the City's request, Kennedy/Jenks Engineers were directed to evaluate the compatibility of treated water from the CWP facility with the City's wastewater treatment plant regulations. The Kennedy/Jenks Engineers (March 19, 1984) evaluation concluded that a discharge of 40,000 gallons per day of wastewater containing no more than 0.5 mg/l of hexavalent chromium would be acceptable under the limitations of restricted discharges. The acceptability of the wastewater discharge would be subject to verification of the existing baseline (pre-discharge) levels of chromium present in the City sewage and sludge. The baseline data were subsequently generated and submitted to the City. On April 30, 1987, CWP submitted a proposal to discharge the electrochemically-treated water during those periods when extracted ground water cannot be recycled or stored on site (CWP, April 30, 1987). This proposal provided the required baseline data and the electrochemical treatment unit influent and effluent chromium concentrations. The data provided demonstrated that the existing discharge limitations can be complied with. The maximum chromium concentration in the electrochemical treatment system effluent was specified as 0.1 mg/l. The City has provided CWP with an authorization to discharge subject to certain provisions, prohibitions, and requirements. CWP is currently reviewing the City's requirements.

7.1.4.3 Discharge into the Surface Drainage System

Another possible method of handling excess treated water is discharge to the surface drainage ditch to the east of the site. As discussed in Section 4.3, this drainage ditch eventually reports to the Russian River, although some seepage into the valley fill deposits is likely to occur. The ditch has the capacity to accept excess discharged water, even during peak flow periods. Implementation of this option would only be possible if restrictions on discharge into the Russian River and its

tributaries are relaxed. The probable development of more stringent discharge restrictions does not make this option a promising or feasible alternative at this time.

7.1.4.4 Subsurface Injection

Injection of excess treated water into the more permeable strata beneath the site is more appropriate during the dry seasons when ground water levels are generally lower. CWP has attempted to implement this option by installing Injection Well CWP-19 upgradient of the contaminated zone. During the wet winter months, however, when the volume of water to be disposed is greatest, Well CWP-19 has not been able to accommodate the required flow. During the drier months when ground water is deeper, this discharge alternative may be necessary in order to flush the contaminants toward the extraction well. One of the major disadvantages of this method is bio-fouling and microbial growth in the injection wells, requiring frequent maintenance.

7.2 RECOMMENDED REMEDIAL ACTION

This section describes the recommended remedial action based on the screening of various alternatives presented in Section 7.1. The rationale for selection of the recommended alternative and rejection of the others, and a description of the environmental effects of the recommended alternative are also provided. The components of the recommended remedial action plan are as follows:

- Surface runoff management
- Control of contaminated soil
- Plume control and aquifer remediation
- Electrochemical treatment of ground water
- Water recycling/discharge to the Ukiah Sewage Treatment Plant or reinjection.
- Monitoring.

Each of the above components is described below.

7.2.1 Surface Runoff Flow Management

Surface runoff shall be controlled in order to prevent the discharge of potentially contaminated water to surface waters. The remaining unpaved portions of the site shall be paved. The area located adjacent to the 330,000 gallon storage tank shall also be regraded and repaved to prevent ponding. The site shall be inspected periodically, at least once per year before the wet season, and surface paving and drainage features repaired as appropriate. Particular attention shall be given to areas around the sumps and retorts. Mobile equipment (e.g., forklifts) shall be designated for exclusive use in the retort area, treated wood storage area, or untreated wood storage area to prevent cross surface contamination. Storm water monitoring shall be performed in accordance with RWQCB Order No. 85-101. The results of storm water quality monitoring will be evaluated and appropriate actions taken accordingly.

7.2.2 Control of Contaminated Soil

The contaminated soil shall be controlled by preventing surface water infiltration and by exercising hydraulic control of the plume in Zone 1. As described in Section 5.0, these remedial measures have been partially implemented at the CWP site. Surface paving has been installed to prevent the passage of water through the near-surface, chromium-containing soil. Consequently, the soil is not expected to be a significant source of contamination by surface water infiltration during the operation of the facility. Post-closure remedial measures include on-site treatment of the contaminated soil to a depth of 1.5 feet for areas containing greater than 100 mg/kg total chromium and 15 mg/kg of arsenic. Beneath and around the retort and sump areas, depth of excavation is expected to be 5 feet. Treatability studies will be conducted prior to selecting the final soil remedy at the time of closure of the facility. (See table 16)

Contaminated soil that comes in contact with ground water during seasonal high ground water conditions will be controlled hydraulically. The hydraulic control measures include ground water extraction near the retort area from Well CWP-18 and near the site boundary from Well HL-7. Details of the hydraulic control measures are presented in Section 7.2.3. The proposed approach shall prevent direct human exposure to contaminated soil, eliminate the contribution of infiltrating surface water to ground water contamination, and prevent off-site migration. Implementation of these measures, combined with proper treated wood handling practices, should gradually improve the site conditions. The criteria for evaluating such improvements include the trend of chromium concentrations in wells located near the retort or process area. If no improvement is observed, additional investigation and remediation actions may be required.

7.2.3 Plume Control and Aquifer Remediation

The zone of contamination shall be controlled hydraulically to prevent off-site migration and to gradually remediate the aquifer. This will be accomplished by extracting ground water from locations near the retort area and near the site boundary. A contingency plan has also been developed for off-site ground water extraction, should chromium concentrations exceed a prescribed level for prolonged periods of time. The "action level" and persistence of chromium in off-site wells are to be decided by the regulatory agencies.

Extraction from near the retort area will be performed through Well CWP-18, which intercepts the chromium plume in Zone 1. Although this well cannot sustain continuous pumping at high flow rates, the impact of intermittent pumping is still believed to be significant because of the high chromium concentrations in ground water in that area.

Extraction from near the site boundary shall be performed through Well HL-7, located to the west (hydraulically upgradient) of the slurry wall. As described in Section 5.0, Well HL-7 is located at the center of a trench which is about 20 feet deep and intercepts the chromium plume approximately perpendicular to the direction of ground water flow. Extraction from Well HL-7 can produce a zone of influence which, in effect, contains the chromium plume and prevents off-site migration. The extraction rate from Well HL-7 shall vary seasonally from 5 to 20 gpm, depending primarily on ground water conditions. The extraction of ground water from Well HL-7, combined with the presence of the slurry wall, is believed to be the principal remediation measure to prevent the off-site migration of chromium.

In addition to containing the chromium plume on site, ground water extraction, particularly from Well HL-7, will also gradually remediate the affected water-bearing zone. Aquifer remediation is accomplished by removing chromium-containing water and replacing it with chromium-free water. To estimate the time required to remediate the water-bearing zone, three factors have been considered, as follows:

- The total fluid present in the water-bearing zone containing elevated chromium concentrations.
- The number of pore volumes required to achieve a given concentration limit.
- The rate of ground water extraction.

Based on the site-specific characteristics and a number of assumptions, the above parameters are discussed below.

Using the most recent areal definition of the chromium plume, the area contained within the 0.02 mg/l isoconcentration is estimated

to be about 130,000 ft^2. Based on the assumptions that the average saturated thickness of the water-bearing zone is 12 feet and its effective porosity is 0.3, the total fluid present in the water-bearing zone is estimated to be about 3.5 million gallons. Approximately 10 pore volumes are estimated to be required to reduce the existing chromium concentrations to 0.05 mg/l. This estimate is based on the following factors and assumptions:

- Laboratory adsorption test data obtained from site-specific soil samples (IT Corporation, June 1985).
- Higher desorption rate under field conditions as compared to laboratory conditions.
- Possible reactions causing fixation and transformation of Cr(VI) to more insoluble forms with time.
- Published and unpublished data on Cr(VI) desorption.
- Inaccuracies and uncertainties associated with data translation from laboratory to field.

The pumping rate from Well HL-7 would vary from about 5 gpm to 20 gpm, depending on seasonal hydrologic conditions, the water demand by CWP's operation, and discharge constraints. Assuming an average pumping rate of 10 gpm for the entire duration of remediation, the time required to remove one pore volume is estimated to be about 8.5 months. Thus, based on the above assumptions and considerations, the estimated time of aquifer cleanup is about seven years.

In the above calculation, it is assumed the soil does not act as a source of chromium to ground water. However, the chromium contaminated soil at the CWP site may continue to act as a source of contamination. Therefore, the actual length of time for aquifer cleanup may be greater than that calculated above. For long-term budgetary purposes, the duration of aquifer cleanup is projected

to be between 7 and 20 years. A more accurate estimate of aquifer cleanup time would be possible provided ground water remediation is monitored and results evaluated. Thus, a long-term monitoring program (Section 7.2.6.3) is needed to establish the performance of the remediation in order to assure that ground water cleanup objectives are achieved.

Hydraulic testing of Well HL-7 has shown that during the winter months, when ground water levels are highest, it is possible to extract 20 gpm from Well HL-7 (Geosystem, March 1986). To accommodate higher extraction rates, discharge of treated water into the sanitary sewer would be required.

Because of the occasional appearance of chromium in Well CWP-8, located to the east of the slurry, extraction from Well CWP-8 is proposed. At the same time, pumping rate of Well HL-7 may be increased to provide a more effective hydraulic barrier. Extraction from Well CWP-8, however, will be effective in reducing or eliminating the source of chromium to off-site areas. The extracted water shall be transferred through a 3-inch line to the sump, as shown in Figure 19. The water will be treated as described earlier. Based on CWP's experience, during wet seasons it is possible to extract 3 to 5 gpm continuously from Well CWP-8.

Because of the occasional presence of dissolved chromium in Well AT-2 above 0.05 mg/l, a contingency plan has been developed to initiate off-site ground water extraction, if needed. The criteria for initiation of off-site extraction are currently being developed by the regulatory agencies, depending on the persistence of chromium above a prescribed concentration.

The off-site extraction program shall include pumping from Well AT-2 or a new extraction well in the same vicinity. The extracted

water shall be transferred, via a 3-inch underground PVC pipe, to the on-site sump, as shown in Figure 19. The off-site ground water quality data indicate that pumping from Well AT-2 would most likely be intermittent, if required at all.

7.2.4 Electrochemical Treatment of Ground Water

Extracted ground water in excess of CWP's water requirements shall be treated using the existing electrochemical unit at the site. This unit is manufactured by Andco Environmental Services (Andco) and is capable of handling up to 150 gpm. However, for greater efficiency, the flow rate shall be maintained below 50 gpm.

As shown in Figure 19, the extracted ground water shall be pumped to the on-site, concrete-lined sump, from which it will be transferred to the treatment unit for processing. After processing, the water will enter the holding tanks for precipitation and retreatment. Subsequently, the water shall be transferred to the 330,000-gallon tank for sampling prior to discharge. From this tank, the water will be pumped through a 4-inch PVC pipeline, parallel to Taylor Drive, and into the sewer main at Plant Road.

The Andco chromate removal system employs a patented electrochemical process designed to reduce total chromium concentrations to less than 0.05 mg/l. The process reduces soluble hexavalent chromium to trivalent chromium which is precipitated as hydroxide, as discussed in Section 7.1.3.1. The precipitate can then be removed from the waste stream by filtration or sedimentation, yielding an effluent containing less than 0.05 mg/l chromium. Tests performed by CWP have demonstrated that the effluent concentration of chromium is generally less than 0.04 mg/l.

Selected data obtained from CWP are as follows:

DATE	INFLUENT CONCENTRATION (mg/l)	EFFLUENT CONCENTRATION (mg/l)
3/06/84	5.3	0.02
11/05/84	6.8	0.02
11/06/84 (Sample 1)	169	0.02
11/06/84 (Sample 2)	160	0.07

The Andco chromate removal system consists of two electrochemical cells connected in series, two separate DC power sources contained in one cabinet, and an acid wash system. The cell housings and acid tank are constructed of fiberglass and all interconnecting piping is of PVC. The incoming stream passes into the first cell via a 3-inch line which includes a flow meter and a pressure gauge. The stream then passes through the second cell and exits via a three-way valve for direct discharge from the treatment stream. A second pressure gauge is included in the discharge line. A strainer and gas relief valve are fitted to the top of each cell to provide a release for hydrogen generated during the electrochemical process and shutoff during acid washing. The bottom of each cell is piped to the acid pump for drainage prior to and after acid washing and for drainage prior to cell replacement (Andco, June 1987).

The acid wash system consists of an acid storage tank, acid pump, and interconnecting piping to allow acid washing of the cells on a daily basis. Acid washing prevents coating of the electrode surfaces and the corresponding loss in treatment system efficiency. The procedure is relatively simple to perform and requires only about 15 minutes per day to accomplish. Two to three times a week, the acid concentration should be checked and kept to 8 to 10 percent by the addition of fresh muriatic acid. On a monthly

basis, the spent acid can be neutralized and bled into the discharge line and new acid made up. The electrode plates have a normal life of about one million gallons at an influent concentration of 10 to 11 mg/l of Cr(VI).

Subsequent to the initial treatment, the water shall be transferred to holding tanks, located north of the tank farm, where the metal hydroxides are precipitated. After precipitation is completed, the water could be passed through the treatment unit a second time to assure compliance with effluent limitations. The effluent shall be transferred to the 330,000-gallon tank for testing and storage prior to discharge. The tank is connected to the sanitary sewer located at the intersection of Taylor Drive and Plant Road (Figure 19). The resulting sludge shall be handled according to the appropriate EPA and DHS regulations.

7.2.5 <u>Water Reuse/Discharge to the Ukiah Sewage Treatment Plant or Reinjection</u>

Extracted ground water will be recycled into CWP's wood preserving operations to the extent possible. Excess ground water which cannot be recycled into the wood preserving operations will be treated electrochemically as described in the previous section and discharged. Among the viable discharge options considered in Section 7.1.4, discharge into the sanitary sewer during the wet months or reinjection during the dry months appear to be the most practical methods. Discharge to the Ukiah Sewage Treatment Plant must meet pretreatment requirements. On December 23, 1987, a draft permit to discharge pretreated ground water was issued by the City. The draft document outlines the requirements which need to be met prior to allowing CWP to discharge the treated ground water. CWP has proposed to discharge treated water in a batch mode after monitoring. The initial monitoring program, as specified by the

City, is presented in Table 15. CWP is currently reviewing the draft document and preparing a response.

7.2.6 Monitoring

Monitoring is an integral part of remediation to document the performance and efficiency of the extraction/treatment system. Based on the monitoring results, recommendations, and modifications shall be made for further site improvements, as appropriate. Various elements of the proposed monitoring program are described below.

7.2.6.1 Air Quality Monitoring

The recommended remedial action does not require air monitoring; however, as part of routine wood preserving operations, air quality is monitored on a periodic basis. Air quality monitoring pertinent to RAP requirements shall be evaluated if contaminated soil is to be excavated for remediation or otherwise disturbed. The air quality monitoring plan will be part of the overall health and safety plan and according to OSHA requirements.

7.2.6.2 Storm Water Monitoring

Storm water monitoring, as specified by the RWQCB, shall be performed at Stations NE, NW, and C-100, the locations of which are shown in Figure 2. These locations have been selected to provide an indication of the quality of surface runoff from the CWP site. This is of importance as the surface drainage system ultimately drains into the Russian River. Storm water samples shall be collected once per month during any precipitation event sufficient to produce a flow of water in the subject ditches. The samples shall be analyzed for dissolved total chromium and arsenic. Storm water monitoring results shall be compiled and reported to the RWQCB as specified in Revised Monitoring and Reporting Program No. 85-101 (RWQCB, May 1987). The results shall be evaluated and

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recommendations and modifications regarding overall facility improvements shall be made as appropriate.

7.2.6.3 Ground Water Monitoring

A ground water monitoring program (RWQCB, May 1987) is in effect to evaluate the ground water flow regime and the distribution of chromium throughout the study area. Monitoring includes ground water level measurements and ground water quality sampling/ analysis. The ground water monitoring results shall be used to evaluate the effectiveness of the hydraulic control measures implemented. Recommendations regarding additional mitigation measures will be made as appropriate.

The ground water samples will be analyzed for total chromium as specified in Revised Monitoring and Reporting Program No. 85-101, (RWQCB, May 1987). The monitoring shall be performed according to the procedures outlined in the "Ground Water/Storm Water Monitoring Protocol" (Geosystem, August 1987, or its subsequent revisions) prepared specifically for the CWP facility.

The results of the ground water monitoring shall be reviewed on a quarterly basis and reported to the RWQCB as required by Revised Monitoring and Reporting Program No. 85-101 (RWQCB, May 1987). Based on the evaluation of the monitoring results, recommendations and modifications shall be made as appropriate and subject to RWQCB approval.

7.2.6.4 Treatment System Monitoring

During the operation of the electrochemical unit, the influent and effluent concentrations shall be monitored for hexavalent chromium and total chromium. The monitoring frequency shall be in accordance with the requirements of the Ukiah Sewage Treatment Plant, as outlined in Table 15.

7.3 REASONS FOR SELECTION OF THE RECOMMENDED REMEDIAL ACTION

Environmental and public health criteria and cost were the principal considerations in the selection of the proposed remedial action plan. Specific reasons for selection of various components of the plan are as follows:

- Paving of the areas of soil in which higher chromium concentrations have been measured prevents surface water infiltration and reduces the potential for leaching of chromium.

- On-site treatment of soil after site closure provides a permanent remedy for the contaminated soil.

- Extraction from Recovery Well CWP-18 removes chromium-containing ground water in areas where chromium concentrations are highest, thus reducing the source to downgradient areas.

- Extraction from Well HL-7, in combination with the slurry cutoff wall, is effective in containing the chromium plume on site and gradually remediating the aquifer.

- Extraction from Well CWP-8 would contain any residual chromium to the east of the slurry wall and prevent further downgradient migration to off-site areas.

- Use of the electrochemical unit is an environmentally and economically sound approach for ground water treatment.

- Discharge of the treated water into the Ukiah Sewage Treatment Plan is the most flexible and environmentally sound approach.

- The proposed monitoring plan provides sufficient data to demonstrate the effectiveness of the remedial action plan and to identify the need for additional remedial actions, if any.

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The reasons for rejecting other alternatives are broadly categorized as follows:

- o Marginal environmental enhancement at the expense of an "order magnitude" increase in cost, as illustrated by cost estimates for soil removal.
- o Environmental unacceptability and lack of proven technology for all hydraulic control measures except the selected option.
- o Technical difficulties for ground water injection during wet seasons.
- o Inefficiency and relative high cost associated with other treatment technologies compared with the electrochemical process.

7.4 ENVIRONMENTAL EFFECTS OF THE SELECTED REMEDIAL ACTION

In general, the selected remedial plan will minimize potential adverse impacts on human health and the environment. The specific features of the remedial plan, with respect to environmental effects, are described below.

7.4.1 Control of Contaminated Soil

Routine maintenance of surface paving over areas of soil contamination shall prevent direct exposure to contaminated soil and minimize the infiltration of surface waters. Consequently, the top 1 to 2 feet of the soil profile, which have been shown to contain elevated concentrations of chromium and arsenic, will not act as a major source of ground water contamination. The post-closure remediation provides a permanent remedy for the on-site contaminated soils.

7.4.2 Plume Control

The two major objectives of plume control are preventing off-site migration and remediating existing contamination in the on-site

water-bearing zone. Off-site migration is controlled by the combination of the slurry cutoff wall and extraction of ground water from Wells HL-7 and CWP-8. On-site remediation is accomplished by ground water extraction from Wells HL-7 and CWP-18. Water quality data have demonstrated that these hydraulic control measures have been effective in preventing the off-site migration of chromium. Subsequent to construction of the slurry wall in October 1983, chromium concentrations in off-site wells have generally decreased with time, as described in Section 4.5.3.

Based on the current chromium concentrations in off-site wells and the continuing trend of decreasing chromium concentrations, no remediation is proposed for off-site areas. However, a contingency plan is developed to address off-site remediation when the criteria for such remediation are established by the regulatory agencies. To demonstrate the potential environmental impacts of selection of the "no action" alternative for off-site areas, the transport of chromium was simulated using a two-dimensional areal model (Geosystem, April 1987). Details of this modeling effort are presented in Appendix E. The model results demonstrated the following:

- Under present conditions, downgradient receptors will not be adversely impacted.
- Dispersion and attenuation mechanisms will continue to reduce chromium concentrations in downgradient areas.

7.4.3 Monitoring

The proposed monitoring program is designed to detect any significant environmental changes and to provide early warning to the responsible parties. Using the monitoring data, the effectiveness of the proposed remedial action plan shall be

evaluated. This evaluation shall be used as a basis for modification of the remedial action plan, if necessary.

7.5 APPLICABLE LAWS AND REGULATIONS

The CWP site is included on the State Superfund and National Priority Lists and is, thus, subject to both state and federal laws and regulations. Although the more formal and systematic soil and ground water quality investigations at the site began in June 1980, a certain amount of monitoring was performed in the 1970s by the RWQCB. During the early phases of the investigations, however, many of the current regulations and guidelines were not in effect. Therefore, investigation and remediation activities were not always performed in accordance with the state and federal laws currently in effect. Certain activities were performed by CWP without authorization of the regulatory agencies (Appendix A).

As required by the National Contingency Plan (NCP 1985) and Superfund Amendment and Reauthorization Act (SARA 1986), applicable or relevant and appropriate requirements (ARARs) have been used as a guide to evaluate the appropriate extent of site cleanup, select appropriate remedial action alternatives, and has been and will be used in implementation and operation of the selected remedial action. As required by SARA, state requirements that are more stringent than federal requirements must generally be attained in implementation of remedial actions. These laws and regulations are as follows:

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

- Resource Conservation and Recovery Act (RCRA) of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

- Safe Drinking Water Act.
- California Code of Regulations, Title 22, Division 4: Environmental Health (Chapter 1, Article 1; Chapter 2, Article 1; Chapter 30), July 1986.
- California Health and Safety Code.
- North Coastal Basin Water Quality Control Plan adopted by the RWQCB.
- All orders, including specifications, provisions, prohibitions, and requirements issued by the RWQCB.
- Court order by the State of California, Office of the Attorney General.
- National Contingency Plan, pertinent hazardous waste regulations under 40 CFR, Parts 260 to 265; Part 300-68, July 1985.
- Porter-Cologne Water Quality Control Act, 1969.

Based on a request made by DHS, a draft of the Deed of Restriction on Real Property has been prepared and is included as Appendix G to this document.

Within 30 days after Department approval of the Final RAP Coast Wood Preserving Inc., must record the Final Deed Restriction with Mendocino County.

8.0 IMPLEMENTATION SCHEDULE

mentioned in Section 5.0, the interim remedial measures program has been in effect for some time. Therefore, a number of elements of the recommended remedial action plan have already been implemented. According to CWP, pumps and piping associated with ground water extraction from Wells CWP-18, HL-7, and CWP-8 are in place and in operating condition. Also, the electrochemical unit is on site and in operating condition.

Subsequent to approval of the RAP, the following activities need to be completed prior to full-scale operation:

- Final permit from the City for discharge of treated water into the sanitary sewer.
- Connecting the line to the sewer system.
- Permitting, design, and construction of off-site extraction system, if needed.
- System startup and testing.

Because of uncertainties associated with the time of approval of the RAP and obtaining the permit to discharge into the sanitary sewer, the real time schedule is not known. Connecting the line to the sewer system, construction of the off-site extraction system, if needed, and system startup can be completed within a 3-month period.

Revised see table 1 attached in 9/24/90 letter

9.0 ALLOCATION OF FINANCIAL RESPONSIBILITY AND PROVISIONS FOR FINANCIAL ASSURANCE

The Coast Wood facility has been owned and operated by Coast Wood Preserving, Inc. since 1971. As the responsible party, Coast Wood shall be one-hundred percent responsible for the implementation of the Remedial Action Plan (RAP) and the associated monitoring operations, and maintenance requirements.

In order to provide the funding required by Coast Wood to implement the provisions of the RAP (regarding soil and groundwater cleanup at the site) Coast Wood will establish an interest bearing trust fund. The trust fund will be for cleanup activities at the end of the business life at the site and for emergency response actions during active operations.

The amount of funds required for the trust account is currently estimated at $1,005,000 (calculated based upon Coast Wood's cost estimate, table 12).

The trust fund will be generated by an annual deposit to be calculated as follows:

$$\text{Payment} = \frac{CE - CV}{Y}$$

CE = cost estimate
CV = current value of the trust fund
Y = years remaining in pay-in period

The annual payment will be $100,500 for 10 years, as calculated below.

$$\frac{\$1,005,000 - 0}{10} = \$100,500$$

The trust fund shall be fully funded within 10 years or by the end of the active life of the facility, whichever occurs first.

A trust fund agreement will be arranged between the Department and Coast Wood Preserving, Inc., designating the Department as the beneficary.

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September 24, 1990

Ms. Michelle Rembaum
Toxic Substances Control Division
California Department of
Health Services
700 Heinz Ave. 2nd Floor
Berkeley, CA. 94710

Dear Ms. Rebaum:

On July 3rd of this year the project manager for the Coast Wood Preserving, Inc. site in Ukiah, CA. issued a revised cost estimate for the soil remediation described in the previously published Remedial Action Plan. Due to advances made in the technology of treating hazardous soils to render them nonhazardous, it was thought to be proper to solicit a quote from a company that had successfully completed several large scale projects. Attached is copy of this revised estimate.

Coast Wood Preserving would like to incorporate this revised cost estimate as an addition to Table 12, superceeding column 2 "Soil Treatment and On-Site Disposal". As this was the chosen remedial action, its revision requires a change to the trust account amount needed. The revised estimate has a total dollar volume on $412,000 or roughly one third of the previous sum.

Such a revision would lower the yearly contribution from the requested $100,000 to only $30,000. However Coast Wood Preserving would agree to the sum of $50,000 yearly, which would provide a more than 50% cushion for contingencies in excess of project managers normal 10%.

Your comments are solicited and your approval in the next 90 days would be appreciated.

Sincerely,

Gene Pietila

Gene Pietila

GP/sm

10.0 OPERATION AND MAINTENANCE REQUIREMENTS

Operation and maintenance (O&M) requirements will be developed subsequent to system design, installation, and startup. These requirements shall be outlined in an operation and maintenance manual. However, the general O&M requirements related to the following components and features of the recommended remedial action are briefly described.

- o Ground water extraction.
- o Ground water treatment.
- o General system inspection and monitoring.
- o General safety procedures.
- o Evaluation of system effectiveness.
- o Reporting.

10.1 GROUND WATER EXTRACTION

During the startup period, flow adjustments shall be made in accordance with CWP's water recycling requirements and limits of treated water discharge. However, attempts will be made to maximize extraction rates for more effective hydraulic control and remediation. Provisions must be made to record the extraction rate and cumulative flow from each extraction well.

During normal operation, the O&M requirements include flow adjustment and recording, maintenance of pumps and pipelines, calibration of gauges and flow totalizers, periodic system inspection, and record keeping. The O&M manual should provide detailed procedures for flow control and data recording during system operation.

10.2 GROUND WATER TREATMENT

Andco Environmental Services, Inc. has provided CWP with procedures for operating the electrochemical unit existing at the site. Some of the of the operational features of the unit are summarized in

Section 7.2. The Andco operating procedures outline the following steps with sufficient detail for implementation:

- o Startup operation.
- o Daily acid washing and polarity changing.
- o Spent acid disposal.
- o Acid makeup.
- o Shutdown.
- o Electrode replacement.
- o Precautions.

Since installation of the electrochemical unit, CWP has made some modifications to improve its operation. The operator of the extraction/treatment system shall be familiar with these modifications.

10.3 SYSTEM INSPECTION AND MONITORING

It is recommended that the ground water extraction/treatment system be inspected once per day. The inspection should include the extraction well piping and instrumentation; pipelines transferring contaminated water to the sump; main header to the sewer system; and treatment system unit, pipes, and instrumentation. Flow totalizer readings at the extraction wells and the treatment system influent line should be recorded.

System monitoring should be performed according to the requirements set forth by the RWQCB and the City of Ukiah, as provided in the RAP and supplementary documents issued by these agencies.

A daily operation log shall be maintained at the site to record these routine inspections. The log shall be a bound, hard-covered book with numbered pages. In addition to flow totalizer readings and other observations, the operator(s) shall record any problems encountered, the corrective actions taken, and any other relevant information. Each entry shall include the time, date, and the operator's name or initials. The information in the daily

operation log will be used in preparing monthly reports to the RWQCB and in evaluating the effectiveness of the ground water extraction and treatment system.

Information related to water quality sampling shall also be recorded in the log book. This information should include, at a minimum:

- Sample locations;
- Date and time of sample collection;
- Number of containers collected;
- Analyses requested;
- Name of sampling personnel; and
- Comments.

Comments may include such things as odors observed, appearance of the water (turbidity, color, etc.), weather conditions, or other pertinent information.

10.4 GENERAL SAFETY PROCEDURES

The general safety procedures pertinent to the recommended remedial action are as follows:

- Operating equipment shall be frequently checked for signs of leakage, corrosion, or damage. Any such defects noted shall be repaired or otherwise corrected before any adverse consequences result.
- Tools, pipe, and other equipment shall not be left lying around the extraction well heads or around the electrochemical treatment unit.
- Waste material and sludge should be placed in a suitable receptacle or removed from the site according to the appropriate regulations.
- Any spills of contaminated ground water shall be cleaned up immediately and reported, as appropriate.

It is recommended that only persons familiar with the ground water extraction and treatment system perform operation and maintenance activities.

10.5 EVALUATION OF SYSTEM EFFECTIVENESS

Based on ground water monitoring data, the effectiveness of the extraction/treatment system shall be evaluated. The evaluation will include the hydraulic response of the water-bearing zones to extraction and water quality changes with time. This type of evaluation is usually performed on an annual basis. The results of such evaluations will be used to make projections for aquifer cleanup and modifications to the remediation strategy, if necessary.

10.6 SITE INSPECTION

The site shall be inspected periodically to identify potential migration pathways of the contaminants and take appropriate corrective actions. The asphalt cover particularly in retort and sump areas shall be carefully inspected and repaired accordingly to prevent surface infiltration. Other surface features shall be inspected to prevent migration of wood preserving chemicals into surface waters.

10.7 REPORTING

The reporting requirements during the implementation of the recommended remedial action will be in accordance with the guidelines and procedures set forth by the RWQCB, DHS, EPA, the City, and other regulatory agencies. Monthly progress reports shall be prepared and submitted to the agencies. The progress reports will present a summary of the work performed, data collected, and interpretations made in the preceding month. If changes need to be made, the progress reports will outline the proposed changes for the agencies information and approval. An

annual report shall be prepared summarizing the data obtained and the associated findings, conclusions, and recommendations.

Respectfully submitted,

GEOSYSTEM CONSULTANTS, INC.

Mohsen Mehran

Mohsen Mehran, Ph.D.
Project Manager
(CGWP No. 189)

Philip Miller

Philip Miller
Senior Project Engineer
(RCE No. C 042600)

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11.0 NONBINDING PRELIMINARY ALLOCATION OF RESPONSIBILITY

Upon consideration of all the evidence, the Department of Health Services concludes that the preliminary non-binding allocation of financial responsibility in this RAP is as follows:

Coast Wood Preserving Inc. 100%

11.0 NONBINDING PRELIMINARY ALLOCATION OF RESPONSIBILITY

Upon consideration of all the evidence, the Department of Health Services concludes that the preliminary non-binding allocation of financial responsibility in this RAP is as follows:

Coast Wood Preserving Inc. 100%

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TABLES

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TABLE 1

WELL CONSTRUCTION DETAILS

WELL NO.	GROUND SURFACE ELEVATION[1] (ft. above MSL)	ELEVATION OF REFERENCE POINT[1] (ft. above MSL)	BORING DEPTH (ft.)	PERFORATED INTERVAL (ft. below ground surface)	ZONE MONITORED	CASING DIAMETER (inches)
CWP-1	582.2	582.99	20.0	17 - 19	1	6
CWP-2A	582.6	582.08	17.1	13.5 - 15.5	1	6
CWP-2B	582.6	582.08	11.0	9 - 11	1	6
CWP-3	580.1	580.37	20.0	9 - 12	1[2]	6
CWP-4A	579.2	578.83	12.0	10 - 12	1	6
CWP-4D	579.6	578.76	14.5	10 - 14	1	6
CWP-5	578.2	578.10	20.0	7.5 - 10	1	6
CWP-6	582.5	582.02	14.8	8 - 12	1	6
CWP-7	576.1	576.75	25.0	6 - 25	1 & 2	12
CWP-8	576.7	577.09	23.0	4 - 23	1 & 2	12
CWP-9	578.8	579.21	26.0	6 - 26	1 & 2	12
CWP-11	578.0	579.76	12.0	6 - 11	1	4
CWP-12	576.9	579.29	26.5	13 - 23	1	4
CWP-13	576.4	579.19	41.5	28 - 38	2 & 3	4
CWP-14	576.2	577.65	31.5	18 - 28	1 & 2	4
CWP-15	578.1	579.96	41.5	22 - 32	2	4
CWP-16	578.3	581.84	12.0	7 - 12	1	4
CWP-17	580.0	581.19	46.5	35 - 45	4	4
CWP-18	582.3	582.69	14.0	5 - 14	1	8
CWP-19	584.2	582.37	24.0	6 - 24	1 & 2	8
CWP-20	578.9	578.52	23.0	5 - 23	1	2
CWP-21	576.6	579.39	22.0	5 - 20	1	2
CWP-22	577.3	580.02	28.0	21.8 - 26.8	2	4
HL-7	577.5	578.36	19.0	9 - 19	1	12
FPT-1A	NM[3]	NM	20.0	13 - 18	1	2
FPT-1B	575.3	575.23	9.0	6 - 9	1	2
FPT-2B	569.1	568.68	14.5	10 - 14.5	1	2
FPT-2C	568.9	568.81	8.0	5 - 8	1	2
FPT-3	574.5	575.57	20.0	11 - 16	1[b]	2
FPT-4	572.2	573.30	18.0	4 - 18	1	2
FPT-5	570.0	571.90	17.0	5 - 17	1	2
AT-1	571.8	572.95	16.5	7 - 16	1	4
AT-2	569.9	571.10	17.0	7 - 15.5	1	4
AT-3	568.9	570.04	22.0	9 - 22	1	4
AT-4	570.1	571.33	30.0	17.5 - 27	2	4
AT-5	568.6	569.33	41.0	10.3 - 14.7	1	4

NOTES:
1) Established by level survey on January 7, 1987. Supersede previous elevations.
2) Well construction may cause communication between Zones 1 and 2.
3) NM denotes Not Measured.

TABLE 2

MONTHLY AND ANNUAL MEAN CLIMATOLOGICAL DATA
UKIAH, CALIFORNIA

MONTH	TEMPERATURE[1] (°F)	PRECIPITATION[2] (inches)	WINDSPEED[3] (miles/hour)
January	46.0	7.97	2.9
February	49.8	6.17	3.5
March	51.7	4.62	4.2
April	56.1	2.38	4.5
May	61.6	1.03	4.9
June	67.6	0.32	5.3
July	73.7	0.04	4.5
August	72.7	0.06	4.2
September	69.7	0.46	3.6
October	61.5	1.83	3.2
November	52.7	4.38	2.4
December	47.[illegible]	6.94	2.3
Annual	59.2	36.27	3.8

NOTES:
1) California Energy Commission, "California Solar Data Manual," report prepared by Solar Energy Group, Energy and Environment Division, Lawrence Berkeley Laboratories, 317 pp, 1978.
2) Farrar, C.D., "Groundwater Resources in Mendocino County, California," U.S. Geological Survey, Water-Resources Investigations Report 85-4258, 81 pp, July 1986.
3) California Energy Commission, "California Wind Atlas," report prepared by California Department of Water Resources, 210 pp, April 1985.

TABLE 3

ON-SITE MONTHLY PRECIPITATION RECORDS
(All units are inches)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1981	NA[1]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.6	--
1982	0.8	4.95	8.19	5.66	0[2]	0.30	0	0	0.08	1.26	8.59	7.20	37.03
1983	NA	NA	14.88	6.20	0.30	0	0	0	0	0.10	16.01	13.85	51.34
1984	0.04	3.71	2.30	0.37	0	0	0	0	0	3.30	10.70	2.25	22.67
1985	0.20	3.25	4.19	0	0	0	0	0	1.40	1.80	3.40	2.81	17.05
1986	7.42	15.97	7.39	0.62	0	0	0	0	0	0.80	0.30	3.95	36.45
1987	7.20	4.81	6.10	0.55	0.35	0	0	0	0	2.10	4.10	10.04	35.25
988	8.63	0.45	0.20	1.40	0.60	1.01	0	0	0	0.03	7.22	3.92	23.46

NOTES: 1) NA denotes Not Available.
2) "0" denotes no rainfall.

TABLE 4

WATER-PRODUCING WELL INVENTORY AND CONSTRUCTION DETAILS

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WELL NUMBER	DATE OF COMPLETION	WATER USE	CASING DIAMETER (inches)	PERFORATIONS (feet)	DEPTH (feet)	WELL LOG AVAILABLE
14N/12W-3F1(1)	NA(2)	NA	NA	NA	NA	No
14N/12W-3J1(1)	NA	NA	NA	NA	NA	No
14N/12W-3Q1(1)	NA	NA	NA	NA	NA	No
14N/12W-4B(3)	NA	NA	NA	NA	NA	No
14N/12W-4C	1977	Irrigation	12	35-75	75	Yes
14N/12W-4D1	1972	Irrigation	8	29-68	68	Yes
14N/12W-4D2(3)	NA	NA	NA	NA	NA	No
14N/12W-4E1	6/11/46	NA	12	12-25, 35-36	47	Yes
14N/12W-4G(3)	NA	NA	NA	NA	NA	No
14N/12W-4J(3)	NA	Irrigation	NA	NA	NA	No
14N/12W-4K1(1)	NA	NA	NA	NA	NA	No
14N/12W-4M	1961	Domestic	NA	NA	NA	No
14N/12W-4P1	NA	NA	12	NA	100	Yes
14N/12W-4R1(3)	NA	Irrigation	NA	NA	NA	No
14N/12W-4R2(3)	NA	Irrigation	NA	NA	NA	No
14N/12W-5A1	6/08/48	NA	8	50-62	107	Yes
14N/12W-5A2	4/30/86	Domestic	6	81-101, 121-181	184	Yes
14N/12W-5G1	Deepened 1960	Domestic	NA	NA	NA	No
14N/12W-5G2	1960	Domestic	NA	NA	NA	No
14N/12W-5G3	1963	Irrigation	8	19-29	29	Yes
14N/12W-5H1	1959	Irrigation	NA	NA	NA	No
14N/12W-5H2	1977	Irrigation	8	18-50	100	Yes
14N/12W-5K1	1952	Domestic	8	69-85.5	94	Yes
14N/12W-5N1	1962	Domestic	NA	NA	NA	No
14N/12W-5P	1970	Domestic	NA	NA	NA	No
14N/12W-5N2	1977	Domestic	NA	NA	NA	No
14N/12W-5 (4)	1974	Domestic	NA	NA	NA	No
14N/12W-5 (4)	1977	Domestic	NA	NA	NA	No
14N/12W-5 (4)	1977	Domestic	6	271-295	295	Yes

TABLE 4
(Continued)

WELL NUMBER	DATE OF COMPLETION	WATER USE	CASING DIAMETER (inches)	PERFORATIONS (feet)	DEPTH (feet)	WELL LOG AVAILABLE
15N/12W-32L1	1960	Domestic	14	NA	30	Yes
15N/12W-32L2	1977	Domestic	8	12-22	22	Yes
15N/12W-32L3	1977	Domestic	NA	NA	NA	No
15N/12W-32 [4]	1973	Irrigation	NA	NA	NA	No
15N/12W-32Q1 [1]	NA	Domestic	12	NA	65	No
15N/12W-33D	1969	Domestic	12	18-58	58	Yes
15N/12W-33E1 [5]	NA	Irrigation	6	NA	25	No
15N/12W-33E2 [5]	7/22/53	Municipal	16	30-47, 76-104	108	Yes
15N/12W-33E3	1955	Municipal	84	22-33	33	No
15N/12W-33E4	1959	Municipal	84	15-29	29	No
15N/12W-33E5	1972	Municipal	12	32-104	104	Yes
15N/12W-33E6	1972	Municipal	16	40-50, 60-115	130	Yes
15N/12W-33J8	1966	Irrigation	12	35-44, 50-54, 61-78, 84-100, 105-112, 120-123	125	Yes
15N/12W-33N1	1971	Domestic	NA	NA	NA	No
15N/12W-33N2 [3]	NA	NA	NA	NA	NA	No
15N/12W-33M [3]	NA	NA	NA	NA	NA	No
15N/12W-34E1 [1]	NA	Irrigation	24	NA	24	No
15N/12W-35D	1976	Irrigation	8	86-106	111	Yes

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NOTES: 1) From Knight, Durkee, and Banks (1956).
2) NA = Not Available.
3) Wells were located by field inspection (Geosystem).
4) Unable to locate accurately; not plotted on Figure 5.
5) Abandoned.

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TABLE 4
(Continued)

WELL NUMBER	DATE OF COMPLETION	WATER USE	CASING DIAMETER (inches)	PERFORATIONS (feet)	DEPTH (feet)	WELL LOG AVAILABLE
15N/12W-32L1	1960	Domestic	14	NA	30	Yes
15N/12W-32L2	1977	Domestic	8	12-22	22	Yes
15N/12W-32L3	1977	Domestic	NA	NA	NA	No
15N/12W-32 (4)	1973	Irrigation	NA	NA	NA	No
15N/12W-32Q1 (1)	NA	Domestic	12	NA	65	No
15N/12W-33D	1969	Domestic	12	18-58	58	Yes
15N/12W-33E1 (5)	NA	Irrigation	6	NA	25	No
15N/12W-33E2 (5)	7/22/53	Municipal	16	30-47, 76-104	108	Yes
15N/12W-33E3	1955	Municipal	84	22-33	33	No
15N/12W-33E4	1959	Municipal	84	15-29	29	No
15N/12W-33E5	1972	Municipal	12	32-104	104	Yes
15N/12W-33E6	1972	Municipal	16	40-50, 60-115	130	Yes
15N/12W-33J8	1966	Irrigation	12	35-44, 50-54, 61-78, 84-100, 105-112, 120-123	125	Yes
15N/12W-33N1	1971	Domestic	NA	NA	NA	No
15N/12W-33N2 (3)	NA	NA	NA	NA	NA	No
15N/12W-33M (3)	NA	NA	NA	NA	NA	No
15N/12W-34E1 (1)	NA	Irrigation	24	NA	24	No
15N/12W-35D	1976	Irrigation	8	86-106	111	Yes

NOTES: 1) From Knight, Durkee, and Banks (1956).
2) NA = Not Available.
3) Wells were located by field inspection (Geosystem).
4) Unable to locate accurately; not plotted on Figure 5.
5) Abandoned.

TABLE 5

SUMMARY OF AQUIFER PARAMETERS
ZONE 1

PARAMETER	VALUE	SOURCE
Aquifer type	Semi-confined	Boring logs, subsurface profile, field observations(1)
Aquifer thickness	10-15 ft.	Boring logs, subsurface profile
Hydraulic conductivity	1.13×10^{-3} - 3.3×10^{-2} cm/sec	See Table 3
Average hydraulic gradient	0.009	Water level data, January 1987
Effective Porosity	0.3	Assumed
Ground water flow direction:		
On-site	Southeast	Water level data
Off-site	Southeast to South	Water level data
Retardation factor	5	IT Corporation, June 1985

NOTES: 1) The water-bearing zone appears to be confined. In AT-5, ground water was encountered during drilling at a depth of about 13 feet and stabilized at a depth of about 6.0 feet.

TABLE 6

SUMMARY OF PERMEABILITY TEST RESULTS

TYPE OF TEST	PUMPING WELL	OBSERVATION WELL	TESTED ZONE	PERMEABILITY (cm/sec)
Slug test[1]	CWP-6	CWP-6	1	6.6×10^{-3}
Pumping test[1]	CWP-7	FPT-3	1 & 2	1.15×10^{-2}
		FPT-4	1 & 2	3.3×10^{-2}
Slug test[1]	CWP-10	CWP-10	3	5.4×10^{-6}
Slug test[1]	CWP-13	CWP-13	3 & 4	9.65×10^{-5}
Pumping test[2]	HL-7	CWP-5	1	1.5×10^{-2}
Pumping test[2]	CWP-18	CWP-18	1	1.13×10^{-3}
		CWP-6	1	2.93×10^{-3}

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NOTES: 1) Performed by IT Corporation.
2) Performed by Geosystem Consultants, Inc.

TABLE 7

SUMMARY OF JANUARY 1988 MONITORING RESULTS

SAMPLE TYPE	STATION NO. OR SAMPLE I.D.	TOTAL DISSOLVED CONCENTRATION (mg/l) CHROMIUM	ARSENIC
Surface Water	NE	<0.02[1]	<0.004
	NW	<0.02	<0.004
	C-100	<0.02	<0.004
Ground Water	CWP-1	<0.02	
	CWP-2A	0.94	
	CWP-2B	2.7	
	CWP-3	<0.02	
	CWP-4A	Dry	
	CWP-4D	<0.02	
	CWP-5	12	
	CWP-6	50	
	CWP-7	<0.02	
	CWP-8	0.14	
	CWP-9	<0.02	
	CWP-11	<0.02	
	CWP-12	<0.02	
	CWP-13	<0.02	
	CWP-14	<0.02	
	CWP-15	<0.02	
	CWP-16	<0.02	
	CWP-17	<0.02	
	CWP-18	37	
	CWP-20	<0.02	
	CWP-21	<0.02	
	HL-7	5.1	
	AT-1	<0.02	
	AT-2	<0.02	
	AT-3	<0.02	
	AT-4	<0.02	
	AT-5	<0.02	
	FPT-2A	<0.02	
	FPT-3	<0.02	
	FPT-4	<0.02	
	FPT-5	<0.02	

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GEOSYSTEM

TABLE 7
(Continued)

SAMPLE TYPE	STATION NO. OR SAMPLE I.D.	TOTAL DISSOLVED CONCENTRATION (mg/l) CHROMIUM	ARSENIC
Quality Assurance/ Quality Control Samples:			
Duplicates	Duplicate A	<0.02	
	Duplicate B	2.7	
	Duplicate C	<0.02	
Field Method Blanks	FMB-1	<0.02	
	FMB-2	<0.02	

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NOTES: 1) The symbol "<" denotes "less than" the detection limits indicted.
2) Duplicates A, B, and C represent samples from FPT-3, CWP-2B, and AT-2, respectively.
3) Field Method Blanks FMB-1 and FMB-2 represent water samples collected from the bailer after decontamination.

GEOSYSTEM

TABLE 8

TOTAL CHROMIUM IN AMBIENT AIR
AT SELECTED LOCATIONS
IN THE UNITED STATES[1]

LOCATION	YEAR	TOTAL CHROMIUM CONC. (mg/m^3) ARITHMETIC MEAN	MAXIMUM OBSERVED VALUE[2]
Los Angeles, CA	1977	0.0188	0.0666
Grand Canyon National Park, AZ	1977	0.0058	0.0134
Baltimore, MD	1977	0.1568	0.2470[3]
	1979	0.0935	0.4589
Steubenville, OH	1978	0.0517	0.2602
	1978	0.1212	0.6839

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NOTES: 1) Unpublished data from 1977 to 1980 in the National Aerometric Data Bank maintained by the Monitoring and Data Analysis Division of EPA, Research Triangle Park, North Carolina.
2) Values represent maximum 24-hour average.
3) Corrected from Maryland State Yearly Air Quality Data Report, Baltimore, MD, March 1978.

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TABLE 9

CHROMIUM CONTENT OF SOIL AT
SELECTED LOCATIONS IN THE UNITED STATES[1]

LOCATION	SOIL CHARACTERISTIC	CHROMIUM CONTENT (ppm or ug/g)	
		RANGE	MEDIAN
Pennsylvania	Agricultural surface and subsoil	NR	14
Peninsular Florida	Surface and subsoil	<1 to 1,000	50
Florida	Surface and subsoil	<1 to 500	NR
Missouri	On- and off-road soil	NR	71
New Jersey	Various soils	29 to 75	NR
Michigan	Various surface soils	3.2 to 17.6	NR
Ukiah[3]	Agricultural	20 to 40	

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NOTES: 1) Source: Towill et al., 1978.
2) NR = Not Recorded.
3) RWQCB

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TABLE 10

WATER QUALITY CRITERIA SUMMARY

NOTE: This chart is for general information; please use criteria documents or detailed summaries in "Quality Criteria for Water 1986" for regulatory purposes.

COMPOUND	PRIORITY POLLUTANT	EPA CARCINOGENICITY CLASSIFICATION[4]	CONCENTRATIONS IN ug/l: FRESH ACUTE CRITERIA	FRESH CHRONIC CRITERIA	MARINE ACUTE CRITERIA	MARINE CHRONIC CRITERIA	UNITS PER LITER: WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	DRINKING WATER M.C.L.	DATE REFERENCE	NO. OF STATES WITH AQUATIC LIFE STANDARD
Arsenic	Y	A					2.2ng[1]	17.5ng[1]	0.05mg	1980FR	21
Arsenic (pent)	Y	A	850[2]	48[2]	2,319[2]	13[2]				1985FR	21
Arsenic (tri)	Y	A	360	190	69	36				1985FR	21
Chromium (hex)	Y	A	18	11	1,100	50	50ug		0.05mg	1985FR	24
Chromium (tri)	N	A	1,700[3]	210[3]	10,300[2]		170mg	3,433mg	0.05mg	1985FR	24
Copper	Y	D	18[3]	12[3]	2.9	2.9				1985FR	20

NOTES:
1) Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level (LOEL).
2) Human health criteria for carcinogens reported for three risk levels. Value presented in the 10-6 Risk Level.
3) Hardness dependent criteria (100 mg/l used).
4) Group A denotes "human carcinogen" and Group D denotes "not classifiable."

Reference: U.S. Environmental Protection Agency, May 1, 1987, "Quality Criteria for Water 1986," Update #2, Office of Water Regulations and Standards, Criteria and Standards Division.

TABLE 11

PUBLIC HEALTH PROTECTION STANDARDS

MEDIUM	CHEMICAL SPECIES/FORM	RECOMMENDED OR ESTABLISHED STANDARD	REFERENCE
Drinking water	Cr(VI)	0.05 mg/l	U.S. Public Health Standards, 1962
Drinking water	Total Cr	0.05 mg/l	NAS, 1974; U.S. EPA, 1976
Workplace air	Carcinogenic forms of Cr(VI)	0.001 mg/m^3	NIOSH, 1975
Workplace air	Noncarcinogenic forms of Cr(VI)	0.025 mg/m^3 TWA or 0.05 mg/m^3 ceiling	NIOSH, 1975
Ambient water	Cr(VI)	0.05 mg/l	U.S. EPA, 1980
Ambient water	Cr(III)	0.170 mg/l	U.S. EPA, 1980
Ambient Air (?)	(?)	0.15 ug/m^3	CARB Risk Value

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Table 12 Revised

Revised see Section 9

TABLE 1

ESTIMATED COST OF ON-SITE SOIL REMEDIATION

ACTIVITY/TASK	ESTIMATED COST ($)
1. Treatability Study / Design / Planning	7,400
2. Mobilization / Demobilization	9,600
3. Excavation	12,100
4. On-Site Treatment	265,400
5. Field Supervision	25,000
6. Site Restoration	8,700
7. Health and Safety	32,100
8. Chemical Analyses	6,000
9. Reporting	14,000
10. Contingencies	32,100
TOTAL ESTIMATED COST	412,400

NOTES:

1) Treatability Study: $50/hr x 40 hrs = $2,000; expenses = $1,000

Design/Planning: Engineer at $50/hr x 40 hrs = $2,000
Superintendent at $60/hr x 40 hrs = $2,400

2) Mobilization: 2 crew weeks with 2-man crew = 160 hrs x $40/hr = $6,400

Demobilization: 1 crew week with 2-man crew = 80 hrs x $40/hr = $3,200

3) Excavation: $\$1.75/yd^3 \times 1.2 \times 5{,}770\ yd^3 = \$12{,}100$
(Reference: Means Site Work Cost Data, 1988, 7th Edition, R.S. Means Company, Inc.)

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TABLE 12

ESTIMATED COST OF VARIOUS REMEDIAL ACTION ALTERNATIVES
(All amounts are in thousands of dollars)

	SOIL REMOVAL AND OFF-SITE DISPOSAL (4 MONTHS)	SOIL REMOVAL AND ON-SITE TREATMENT (1 YEAR)	IN-SITU TREATMENT (2 YEARS)	PARTIAL EXCAVATION OFF-SITE DISPOSAL (4 MONTHS)	CONTAINMENT (2 YEARS)	NO ACTION (2 YEARS)
Design/Control	10	NA[1]	NA[1]	5	20	5
Mobilization	5	10 - 15	5	5	5	0
Excavation	40 - 50	40 - 50	30[2]	15 - 25	0	0
Transportation/Disposal	1,450	500[3]	260	200 - 275	0	0
Health and Safety	10	30	30	10	10	0
Supervision	20	150	100	10	15 - 20	0
Site Restoration	10	30	30	10	0	0
Contractor Profit	30 - 70	50 - 80	50 - 75	20 - 40	25[4]	0
Laboratory Costs	30 50	50 - 80	50 - 75	15 - 25	12 15	15
Reporting	30 - 40	70	70	10 - 15	12 - 15	15
Total Costs[5]	1,635 - 1,715	930 - 1,005[6]	625 - 675[7]	300 - 420	99 - 110	35

NOTES: 1) NA denotes Not Available; cost depends on design requirements.
2) Asphalt removal.
3) Treatment only.
4) Well developers, samplers.
5) All costs are estimates and are intended to provide relative cost comparisons for remediation alternatives. Inflation factor is not considered.
6) Excluding design costs.
7) Excluding design and field testing costs.

TABLE 13

GROUND WATER TREATMENT TECHNOLOGIES

TECHNOLOGY	INSTALLATION COMPARISONS	PROBABLE COST ($) BASED ON 20 GPM CAPITAL	O & M	COMMENTS
Electrochemical Process	Relies on proven technology	Low	19,500	By far the most effective technique for removing Cr(VI) from ground water; depletes Cr(VI) content of ground water to EPA compatible level.
Chemical Reduction and Precipitation	Relies on proven technology	224,000	192,000	This process generates a large volume of sludge which must be pretreated and disposed.
Chemical Precipitation with Sedimentation or Filtration	Relies on proven technology; limited installation for chromium removal.	192,000	64,000	Effectiveness limited; low removal efficiencies are reported in literature.
Activated Carbon Adsorption	Relies on proven technology.	50,000	328,000	Effectiveness limited.
Ion Exchange	Relies on proven technology.	84,000	14,000	High regeneration cost; fluctuating effluent quality.
Reverse Osmosis	Relies on proven technology.	400,000	150,000	Generates a concentrated stream, 10 to 25 percent of the feed volume, which must be treated further by secondary treatment and high cost.
Electrodialysis	Relies on proven technology.	85,000	11,000	Membrane fouling and clogging by residual colloidal organic matter in ground water; may require more skill and care than other systems discussed in this application.

TABLE 14

REMOVAL OF CHROMIUM BY ELECTROCHEMICAL PROCESS

pH	INITIAL CHROMIUM CONCENTRATION (mg/l)	RESIDUAL CHROMIUM CONCENTRATION (mg/l)	REMOVAL EFFICIENCY (%)	COMMENTS
4.0	195	0.1	99.94	30 minute, current density = 0.0085 A/cm^2
6.8	180	0.04	99.97	50 minute, current density = 0.007 A/cm^2
7.7	150	0.0	100.0	30 minute, current density = 0.011 A/cm^2
8.8	185	0.06	99.96	40 minute, current density = 0.012 A/cm^2
7.6	175	0.1	99.94	60 minute, current density = 0.0085 A/cm^2
8.9	188	0.18	99.90	50 minute, current density = 0.011 A/cm^2

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TABLE 15

CITY OF UKIAH WASTEWATER TREATMENT PLANT
MONITORING PROGRAM FOR COAST WOOD PRESERVING, INC.
DECEMBER 1987

DRAFT

1. WWTP BACKGROUND SCAN, ANNUALLY, PRIOR TO CWP DISCHARGE

LOCATION	FREQUENCY	ANALYSIS[1]
A) Influent	2 at 1 week interval	A, B, C, D, E, F, G, L
B) Pri. Sed. Effluent (water)	2 at 1 week interval	A, B, C, D, E, F, G
C) Pri. Sed. Effluent (sludge)	2 at 1 week interval	E, F, G
D) Final Effluent (water)	2 at 1 week interval	A, B, C, D, E, F, G, L, K
E) Sec. Sed. (sludge)	2 at 1 week interval	E, F, G
F) Digester	2 at 1 week interval	E, F, G, H, I, J
G) Sludge Lagoon	2 at 1 week interval	E, F, G

2. WWTP, DURING DISCHARGE

LOCATION	FREQUENCY	ANALYSIS[1]
A) Influent	Weekly	A, B, C, D, E, F, G, L
B) Pri. Sed. Effluent (water)	Twice per week	A, B, C, D, E, F, G
C) Pri. Sed. Effluent (sludge)	Weekly	E, F, G
D) Final Effluent (water)	Twice per week	A, B, C, D, E, F, G, K, L
E) Sec. Sed. (sludge)	Weekly	E, F, G
F) Digester	Weekly	E, F, G, H, I, J
G) Sludge Lagoon	Monthly	E, F, G

3. CWP, ON-SITE BATCH SCAN BEFORE DISCHARGE

LOCATION	FREQUENCY	ANALYSIS[1]
A) Holding Tank	Each batch	A, B, C, D, E, F, G, M, N

NOTES: 1)

A = BOD	F = arsenic	K = coliform
B = pH	G = copper	L = COD
C = settleable solids	H = volatile acids	M = sulphate
D = NFR	I = total alkalinity	N = 96-hour bioassay (stickleback) See Sect. 3706.4 (I) of City Code.
E = total chromium	J = pH (sludge)	

TABLE 16

Summary of Remedial Action Alternatives: Soils

Alternatives & Descriptions	Protection of Human Health	Compliance with ARAR's	Effectiveness[1] (Long-Term)	Reduction of Toxicity, Mobility & Volume (T,M & V)	Cost[4]	Department of Health Services (DHS) Acceptance
Alt. No. 1 Soil removal (excavation) & off-site disposal	Yes, would eliminate source of contamination.	May not comply with LPR[2]	Effective	No reduction of T, M, & V.[5]	1.7 million	If Alt. 2 is not feasible at time of closure DHS will have to reconsider this option. Does not seem to be promising due to land disposal restrictions.
Alt. No. 2 Soil removal (excavation) & on-site disposal	Yes, if treatibility studies prove feasible.[3]	Yes	Effective	Significant reduction of T, M, & V.	1.0 million	This is the favored option by DHS, provided technology is feasible.
Alt. No. 3 In-situ Treatment	Yes, if treatibility studies prove feasible.[3]	Yes	Maybe Effective	Reduction of T, M, & V may not change	675,000	DHS acceptance is less than Alt. No. 2. due to currently unproven technologies.
Alt. No. 4 Partial excavation & Off-site disposal	Overall protection from this Alt. would be less than alternatives 1,2, & 3.	May not comply with LDR[2]	Less Effective	No reduction of T, M, & V.[5]	420,000	DHS acceptance is low, contaminants are not removed. Land disposal restrictions may apply.
Alt. No. 5 Containment	Capping the site with asphalt will not reduce mobility of contaminants	No	Less Effective	No reduction of T, M, & V	110,000	This presents the greatest potential of release of contaminants if cap fails. Does not result in a permanent solution.
Alt. No. 6 No Action	This Alt. would not reduce present or future exposures to chromium & arsenic. Threat to Human health exists.	No	Not Effective	No reduction of T, M, & V.	0	This is not accepted by DHS. Contaminated soils would not be treated or removed.

TABLE 17

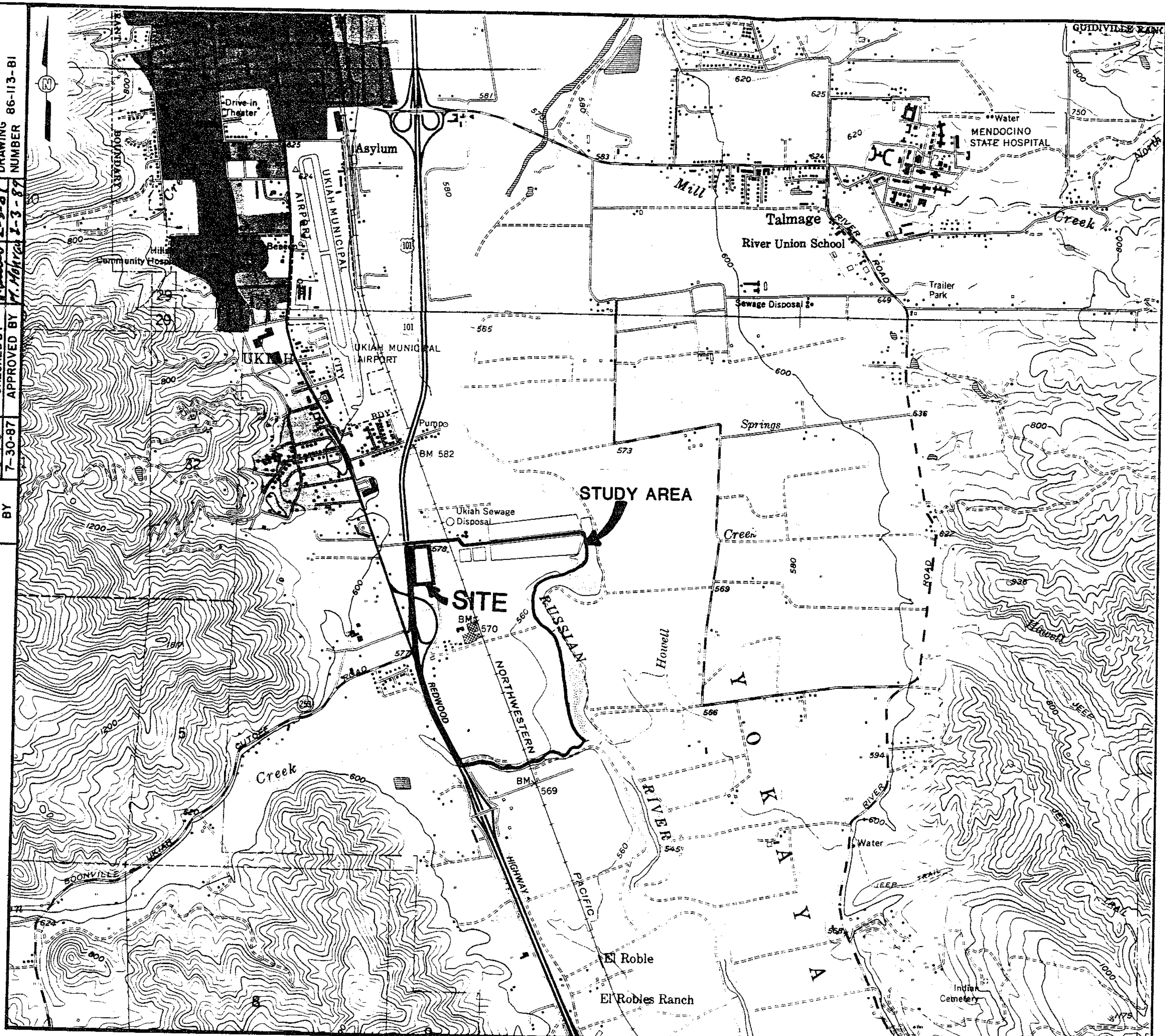
Summary of Remedial Action Alternatives: Groundwater

Alternatives & Descriptions	Protection of Human Health	Compliance with ARAR's	Effectiveness[1] (Long-Term)	Reduction of Toxicity, Mobility & Volume (T,M & V)	Cost[4]	Department of Health Services (DHS) Acceptance
Alt. No. 1 Physical Containment	Yes, keeps the groundwater plume confined.	Yes	Effective	Reduces M	Already imple-mented	This is the favored option by DHS along with groundwater extraction & treatment.
Alt. No. 2 In-situ treatment	Maybe, treat-ment is not a proven technol-ogy yet.	No	Unknown	Unknown	Not available	This is not a proven tech-nology and not accepted by DHS.
Alt. No. 3 Hydraulic Control (groundwater extraction & treatment)	Yes, immedi-ately remediates the groundwater contamination	Yes	Effective	Significantly reduces T, M, & V in combination with physi-cal contain-ment	19,500	This is the favored option by DHS, along with physical containment.
Alt. No. 4 Electrokinetic treatment	Maybe, technol-ogy is still in developmental stage.	No	Unknown	Unknown	Not available	This is not a proven technology at this time. Not accepted by DHS.
Alt. No. 5 No Action	This Alt. would not reduce present or future exposure to chromium and arsenic. Threat to human health and environment exists.	No	No	No	0	This is not accepted by DHS. Contaminated groundwater would not be treated or removed.

Footnotes

1. All remedial action alternatives will require long-term monitoring. In addition, Superfund Amendments and Reauthorization Act (SARA) of 1986 requires review of the remedy effectiveness every 5 years.
2. Land disposal restrictions (LDR) are an applicable or revelant and appropriate requirements (ARRARs) pursuant to the resource convervation and recovery act (RCRA) of 1976.
3. Treatment technologies will be evaluated prior to implementation of the selected remedy.
4. Coast Wood Preserving will be required to set up a trust account. Sufficient funds will be available for the proposed remedial action alternative.
5. Removal or excavation does not reduce the toxicity, mobility or volume. The waste is relocated to another site.

DRAWN BY	S H S 7-30-87
CHECKED BY	2-3-89
APPROVED BY	1-3-89
DRAWING NUMBER	86-113-B1



SCALE

0 2000 4000 FEET

REFERENCE:

BASE MAP - 7.5 MIN. U.S.G.S. (TOPOGRAPHIC) SERIES. ELLEDGE PEAK AND UKIAH QUADRANGLES. DATED: 1958, PHOTOREVISED: 1975, SCALE 1:24,000

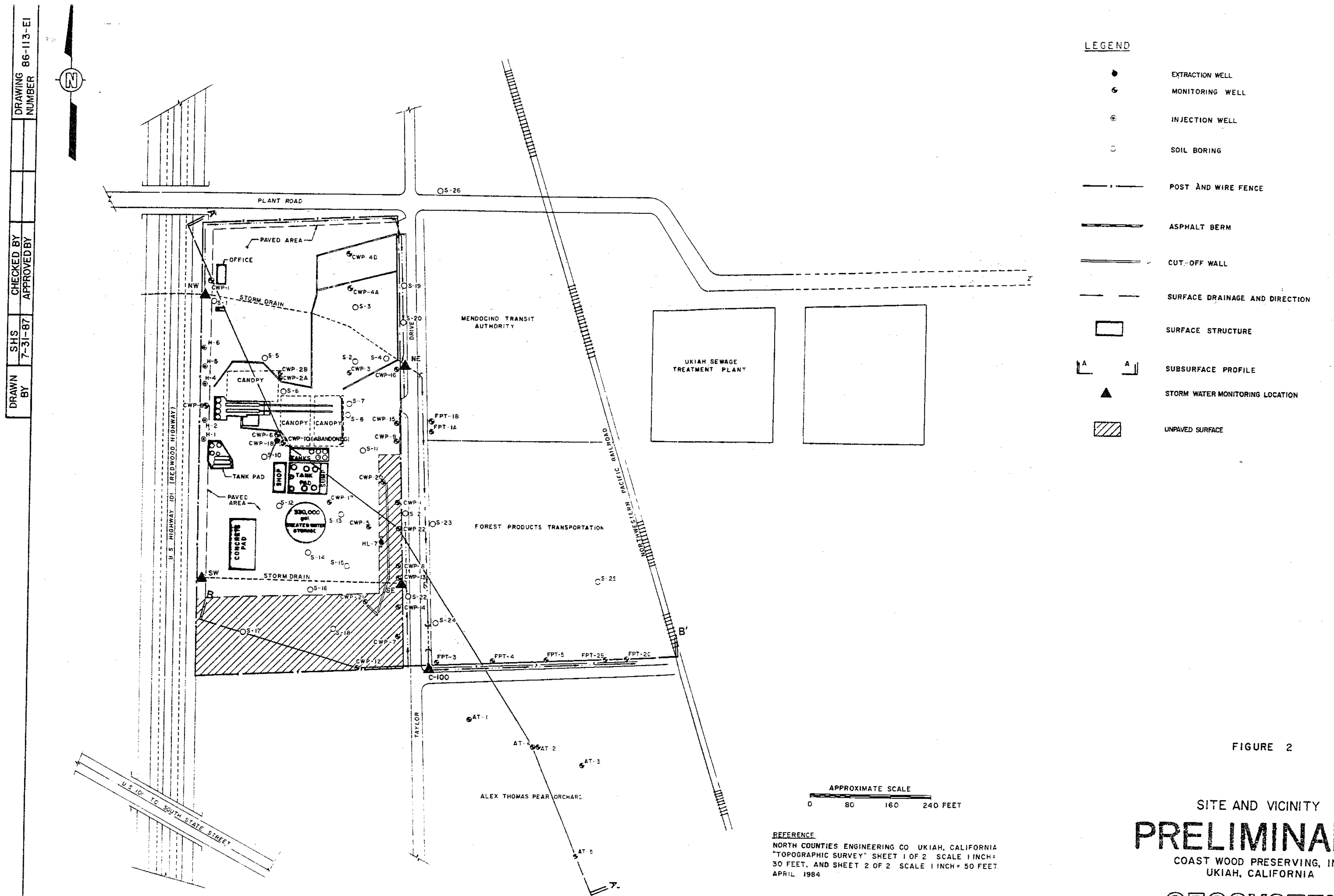
FIGURE 1

SITE LOCATION MAP

PRELIMINARY

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

GEOSYSTEM



REFERENCE

NORTH COUNTIES ENGINEERING CO. UKIAH, CALIFORNIA "TOPOGRAPHIC SURVEY" SHEET 1 OF 2 SCALE 1 INCH= 30 FEET, AND SHEET 2 OF 2 SCALE 1 INCH= 50 FEET. APRIL 1984

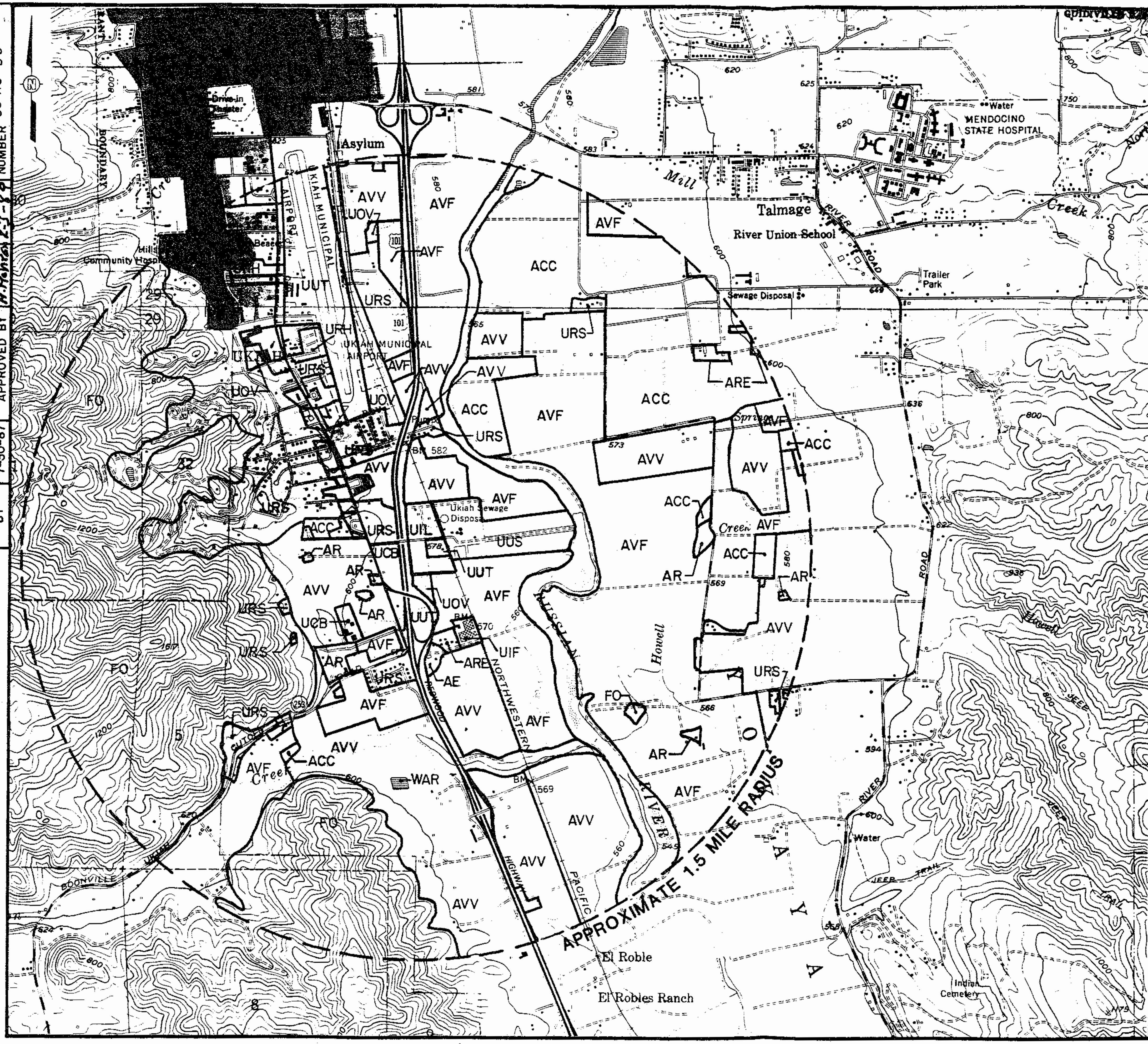
FIGURE 2

SITE AND VICINITY

PRELIMINARY

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

GEOSYSTEM



KEY TO LAND USE

- ACC — CROPLAND
- AR — AGRICULTURAL-RELATED FACILITIES
- ARE — AGRICULTURAL EQUIPMENT STORAGE
- AVF — FRUIT AND NUT TREES
- AVV — VINEYARDS
- FO — FORESTED LAND
- UCB — BUSINESS, PROFESSIONAL
- UIF — FOOD PROCESSING
- UIL — LUMBER MILLS AND STORAGE
- UOV — VACANT OR CLEARED
- URH — MOBILE HOMES
- URS — SINGLE FAMILY RESIDENTIAL
- UUS — SEWAGE PLANTS
- UUT — TRANSPORTATION
- WAR — RESERVOIRS

SCALE

0 2000 4000 FEET

REFERENCE:

BASE MAP - 7.5 MIN. U.S.G.S. (TOPOGRAPHIC) SERIES ELLEDGE PEAK AND UKIAH QUADRANGLES. DATED: 1958, PHOTOREVISED: 1975, SCALE 1:24,000 LAND USE FROM H ESMAILI & ASSOCIATES, INC, AUGUST 1981, AND AERIAL PHOTOGRAPHS DATED 4-22-84

FIGURE 3

SURROUNDING LAND USE

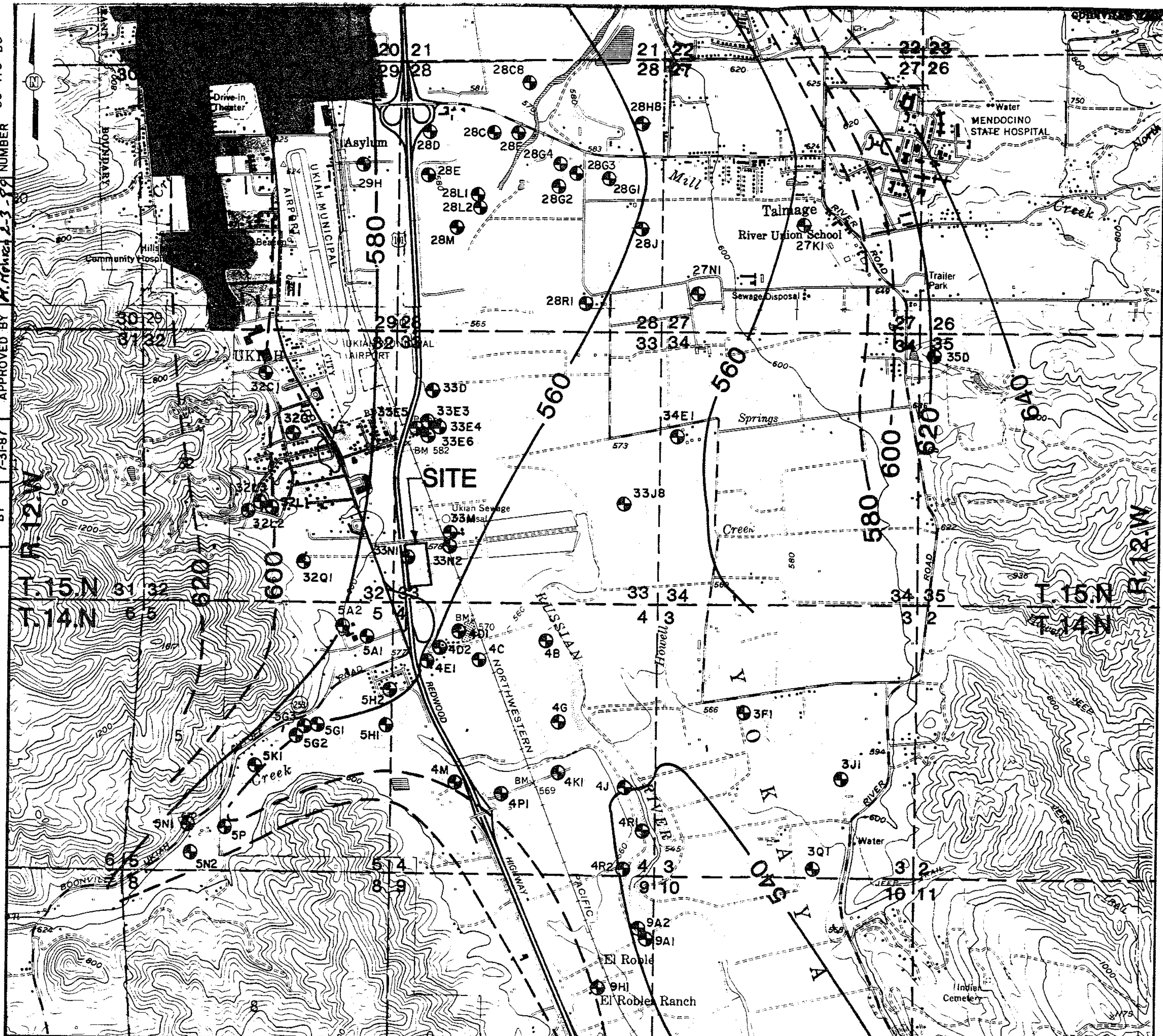
PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	S H S	CHECKED BY		DRAWING NUMBER
	7-30-87	APPROVED BY		86-113-B5

DRAWN BY	SHS	7-31-87
CHECKED BY		2-3-89
APPROVED BY		2-3-89
DRAWING NUMBER	86-113-B3	



LEGEND:

WELL LOCATION (APPROXIMATE)

GROUND WATER CONTOUR, FEET MSL (DASHED WHERE APPROXIMATE)

SCALE

0 2000 4000 FEET

REFERENCE:

BASE MAP - 7.5 MIN. U.S.G.S. (TOPOGRAPHIC) SERIES ELLEDGE PEAK AND UKIAH QUADRANGLES DATED: 1958, PHOTOREVISED: 1975, SCALE 1:24,000
GROUND WATER CONTOURS FROM "GROUND-WATER RESOURCES IN MENDOCINO COUNTY, CALIFORNIA", USGS; WATER-RESOURCES INVESTIGATIONS REPORT 85-4258, JULY 1986

FIGURE 4

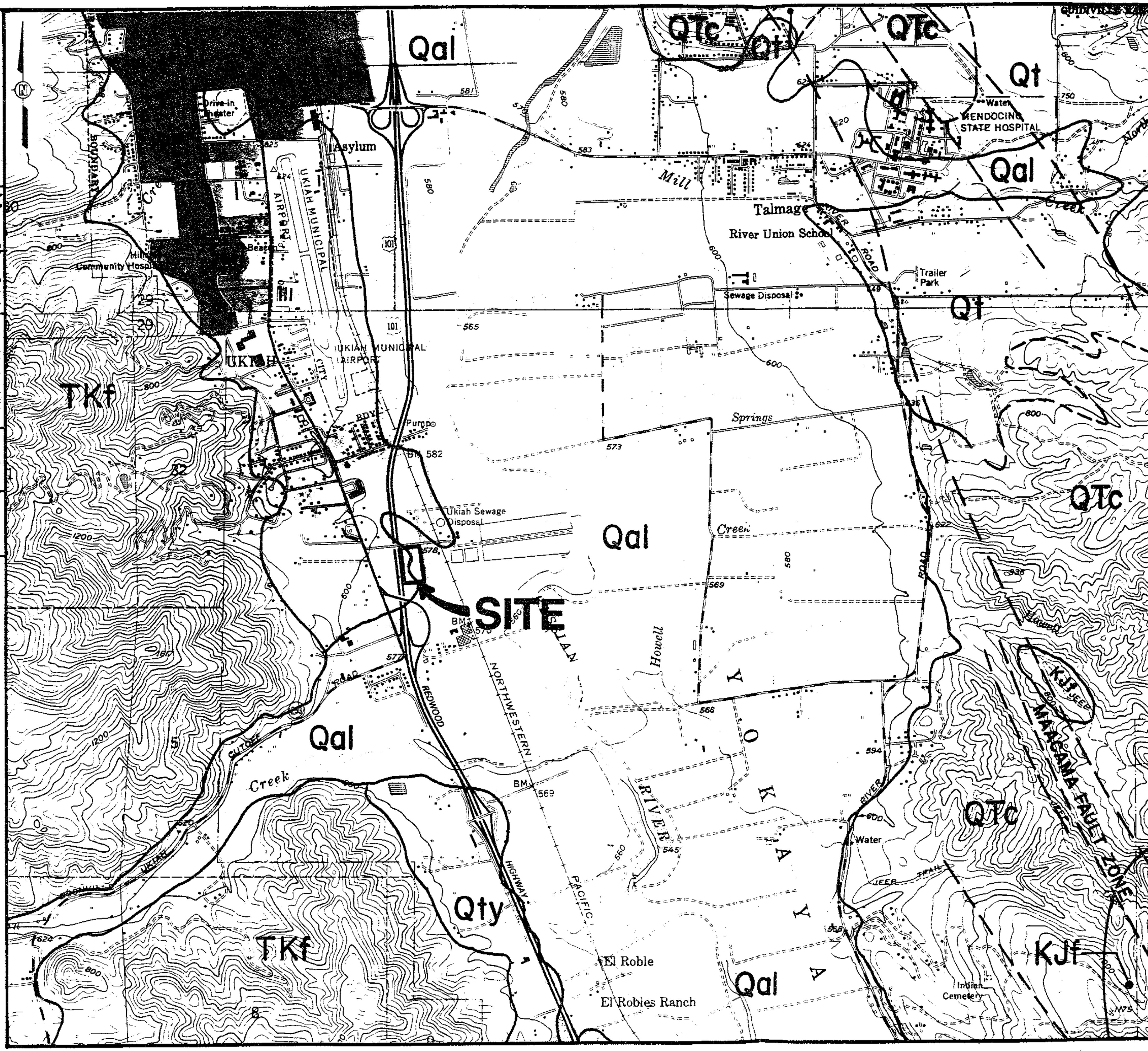
WATER-PRODUCING WELLS AND REGIONAL GROUND WATER CONTOURS

PRELIMINARY

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	S H S 7-30-87	CHECKED BY	APPROVED BY	DRAWING NUMBER 86-113-B2



LEGEND

Qal	Alluvium
Qt	Continental Terrace Deposits, Undifferentiated
Qty	Younger Continental Terrace Deposits
Qto	Older Continental Terrace Deposits
Qtc	Continental Basin Deposits
TKf	Franciscan Complex—Coastal Belt
KJf	Franciscan Complex—Central Belt
——	Contact, dashed where approximate

SCALE

0 2000 4000 FEET

REFERENCE:

BASE MAP - 7.5 MIN. U.S.G.S. (TOPOGRAPHIC) SERIES. ELLEDGE PEAK AND UKIAH QUADRANGLES DATED: 1958, PHOTOREVISED: 1975, SCALE 1:24,000 GEOLOGY FROM "GROUND-WATER RESOURCES IN MENDOCINO COUNTY, CALIFORNIA", USGS WATER-RESOURCES INVESTIGATIONS REPORT 85-4258, JULY 1986

FIGURE 5

REGIONAL GEOLOGY

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
SHS 7-31-87	P. Ulletto 2-3-89	M. Mehran 2-3-89	86-113-A1

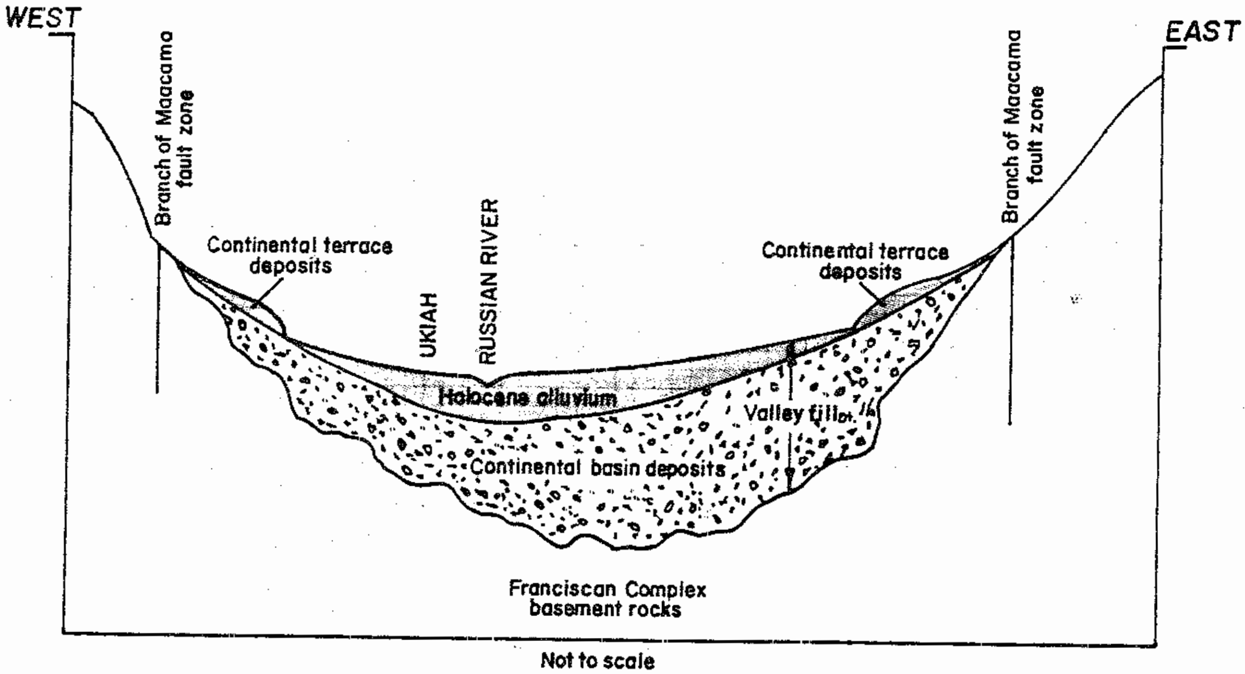


FIGURE 6

PRELIMINARY

SCHEMATIC SECTION THROUGH

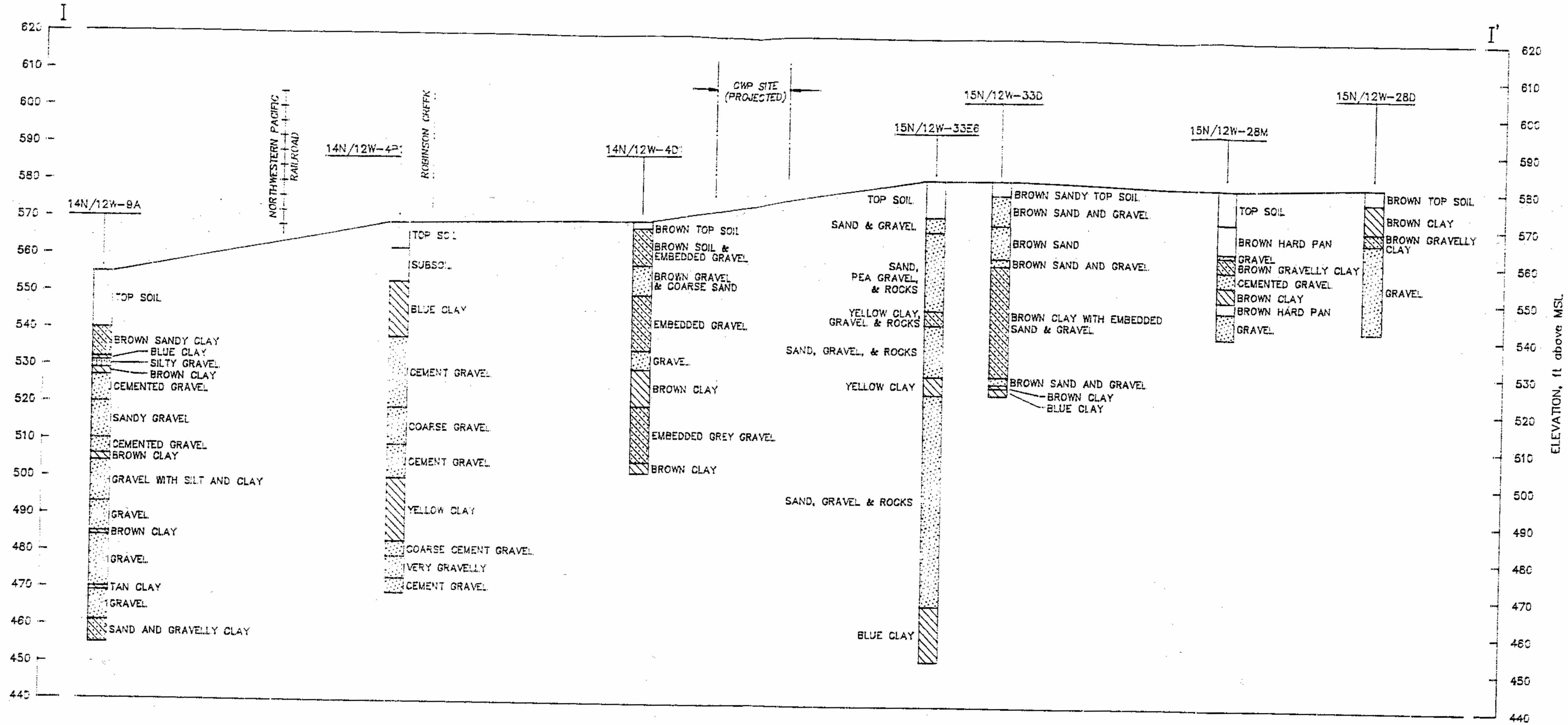
UKIAH VALLEY

REFERENCE:

FARRAR, C. D., JULY 1986, "GROUND-WATER RESOURCES IN MENDOCINO COUNTY, CALIFORNIA," USGS, WATER-RESOURCES INVESTIGATIONS REPORT 85-4258, FIGURE 5

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

GEOSYSTEM



VERTICAL SCALE

0 30 60 FEET

HORIZONTAL SCALE

0 1500 3000 FEET

LEGEND

- CLAY
- SILT
- SAND AND/OR GRAVEL
- CLAY AND SAND/ CLAY AND GRAVEL
- SILT AND GRAVEL

NOTES:

1. THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE INTERPOLATED BETWEEN AND GENERALIZED FROM AVAILABLE DRILLER'S LOGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE LOCATION OF THE BORINGS AND IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE BORINGS MAY VARY FROM THOSE INDICATED.
2. APPROXIMATE GROUND SURFACE ELEVATIONS FROM USGS 7.5 MINUTE SERIES (TOPOGRAPHIC) ELLEDGE PEAK, CALIF. DATED 1958, PHOTOREVISED 1975. SCALE = 1:24000

PRELIMINARY

FIGURE 7

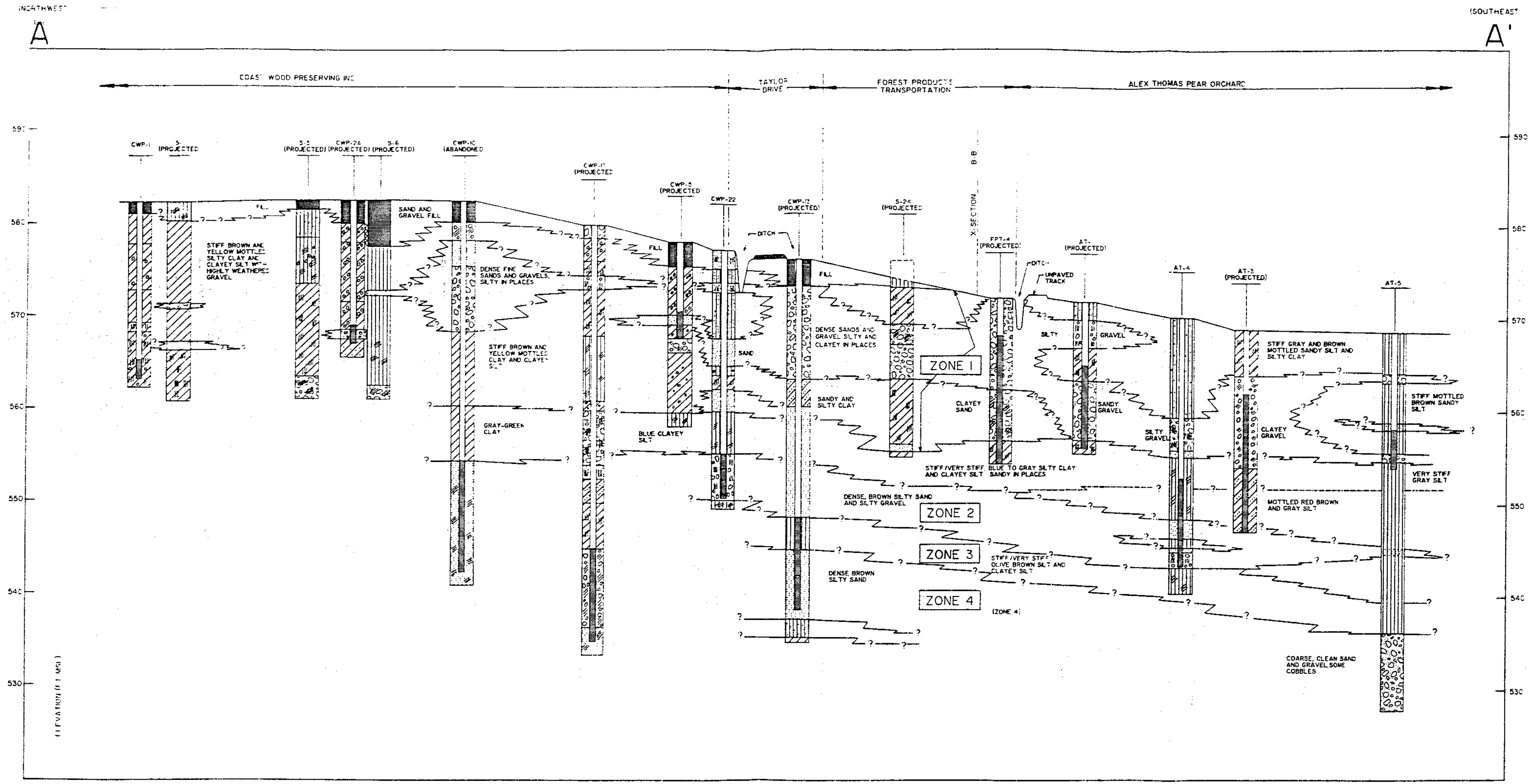
REGIONAL GEOLOGIC SECTION I-I'

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
D.C.H 7/30/87	P. Mueller 2-3-89	H. Mohr 2-3-89	86-113-B4

110378



LEGEND

GRAVEL	SAND	SILT	CLAY
SANDY GRAVEL	GRAVELLY SAND	GRAVELLY SILT	GRAVELLY CLAY
SILTY GRAVEL	SILTY SAND	SANDY SILT	SANDY CLAY
CLAYEY GRAVEL	CLAYEY SAND	CLAYEY SILT	SILTY CLAY

HORIZONTAL SCALE
0 50 100 150 FEET

VERTICAL SCALE
0 5 10 15 FEET

NOTES

1. THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE INTERPOLATED BETWEEN AND GENERALIZED FROM AVAILABLE DRILLERS LOGS INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE LOCATION OF THE BORINGS AND IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE BORINGS MAY VARY FROM THOSE INDICATED

PRELIMINARY

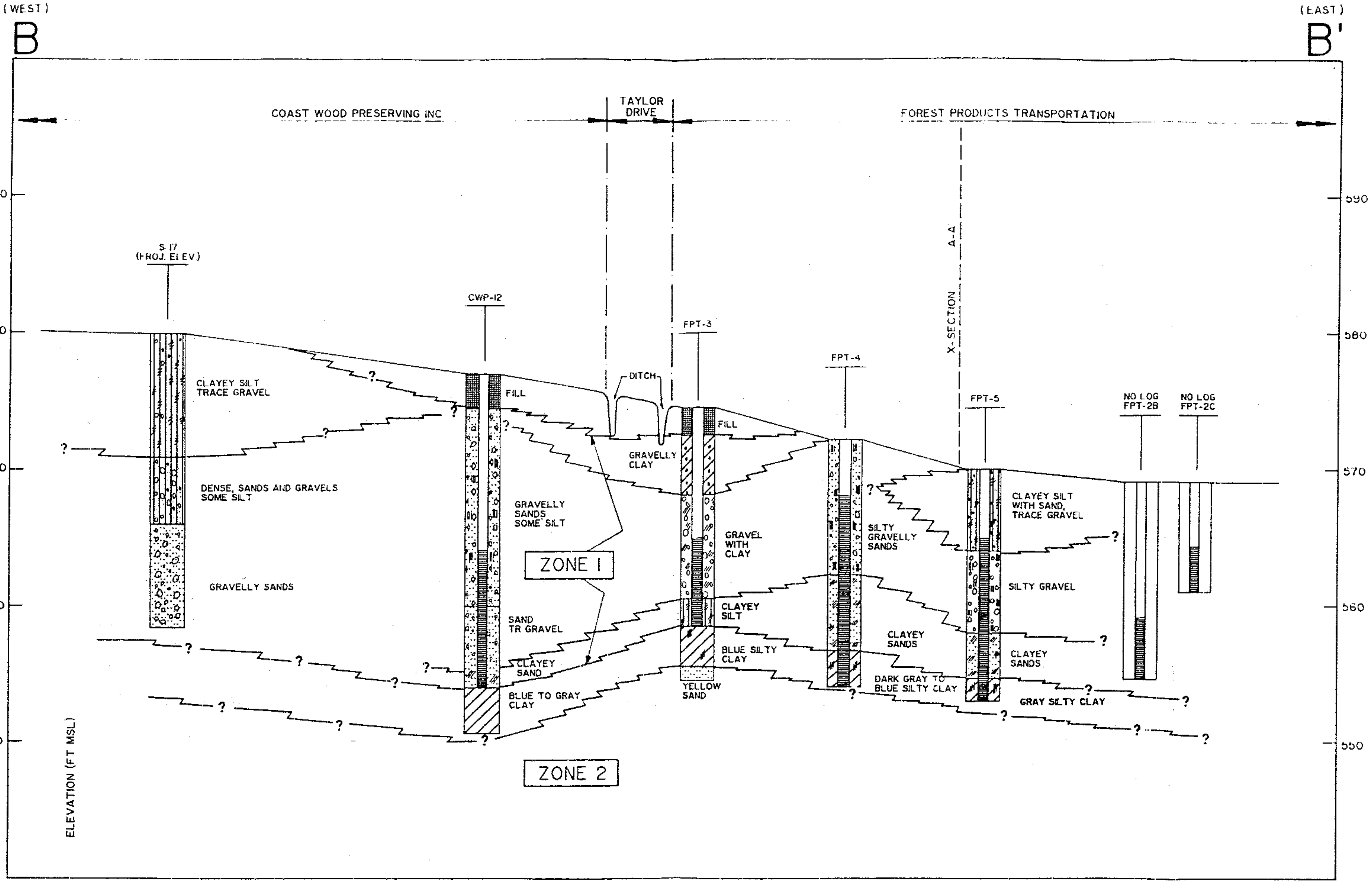
FIGURE 5

SUBSURFACE PROFILE A-A

COAST WOOD PRESERVING INC
UKIAH CALIFORNIA

GEOSYSTEM

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
SKS	[signature]	M. Hutchinson	86113-EG
7-31-87	2-3-87	2-3-89	



LEGEND

GRAVEL	SAND	SILT	CLAY
SANDY GRAVEL	GRAVELLY SAND	GRAVELLY SILT	GRAVELLY CLAY
SILTY GRAVEL	SILTY SAND	SANDY SILT	SANDY CLAY
CLAYEY GRAVEL	CLAYEY SAND	CLAYEY SILT	SILTY CLAY

HORIZONTAL SCALE
0 50 100 150 FEET

VERTICAL SCALE
0 5 10 15 FEET

NOTES:
1. THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE INTERPOLATED BETWEEN AND GENERALIZED FROM AVAILABLE DRILLERS LOGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE LOCATION OF THE BORINGS AND IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE BORINGS MAY VARY FROM THOSE INDICATED

PRELIMINARY

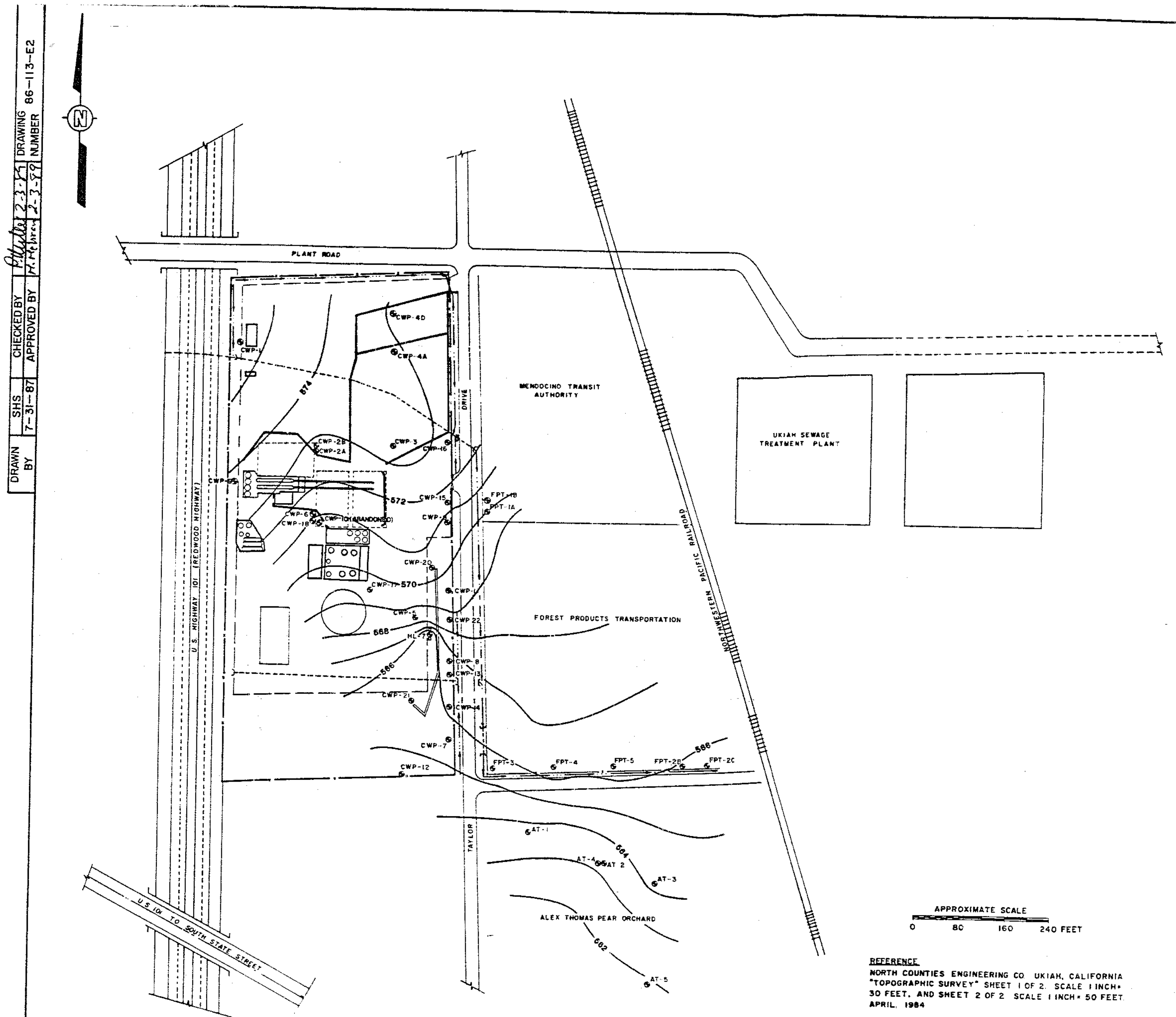
FIGURE 9

SUBSURFACE PROFILE B-B

COAST WOOD PRESERVING INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	SHS	7-31-87
CHECKED BY	P. Wyatt	2-3-89
APPROVED BY	H. Mehran	2-3-89
DRAWING NUMBER	86-113-E7	



LEGEND:

● MONITORING WELL

—562— GROUND WATER CONTOUR (FEET MSL)

APPROXIMATE SCALE

0 80 160 240 FEET

REFERENCE

NORTH COUNTIES ENGINEERING CO. UKIAH, CALIFORNIA "TOPOGRAPHIC SURVEY" SHEET 1 OF 2. SCALE 1 INCH = 30 FEET, AND SHEET 2 OF 2. SCALE 1 INCH = 50 FEET. APRIL, 1984

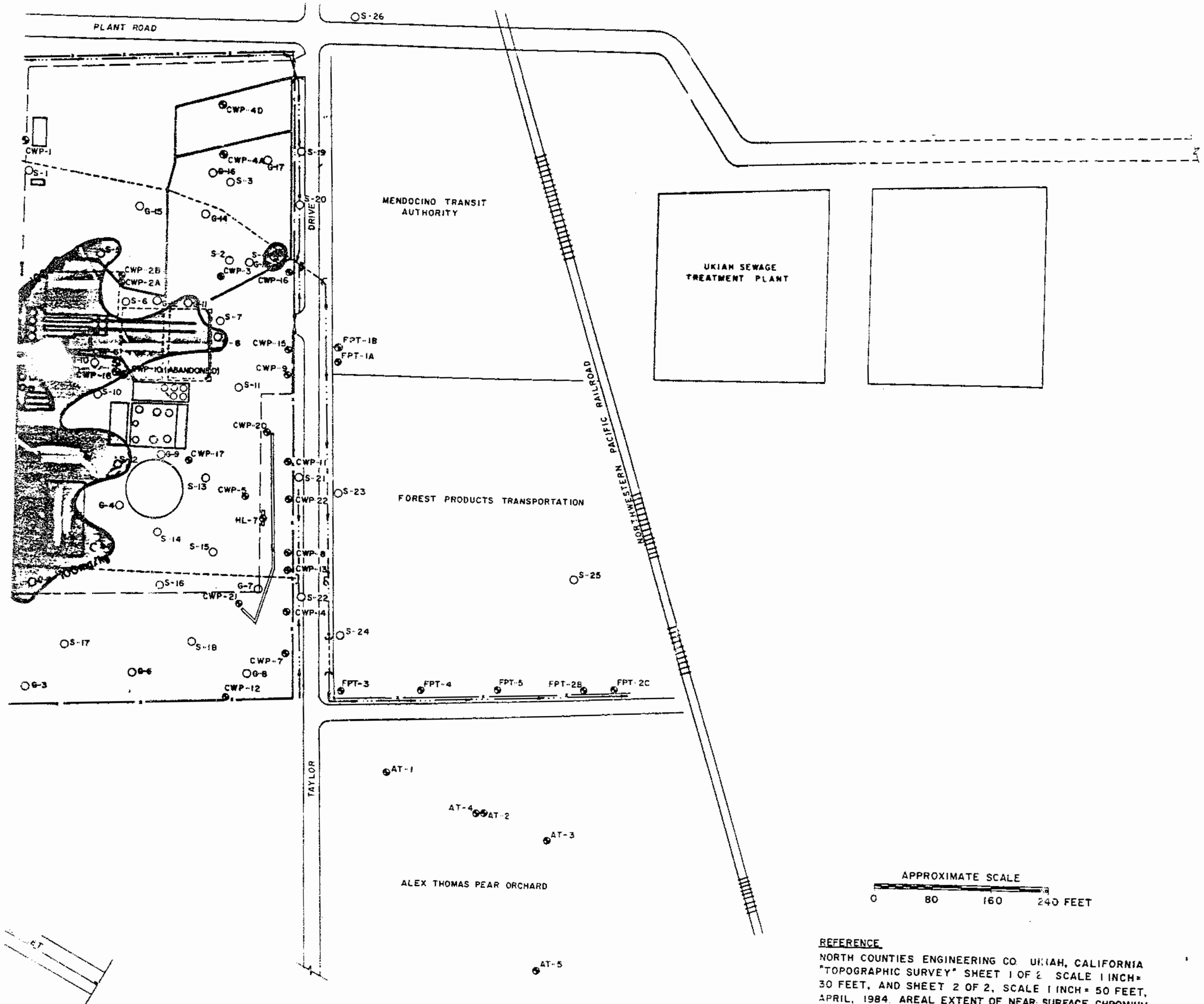
FIGURE 10

GROUND WATER CONTOURS
ZONE I–JANUARY 1987

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM



REFERENCE

NORTH COUNTIES ENGINEERING CO. UKIAH, CALIFORNIA "TOPOGRAPHIC SURVEY" SHEET 1 OF 2 SCALE 1 INCH= 30 FEET, AND SHEET 2 OF 2, SCALE 1 INCH= 50 FEET, APRIL, 1984. AREAL EXTENT OF NEAR SURFACE CHROMIUM IN SOIL FROM D'APPOLONIA, MAY 1984: FIGURE 5.

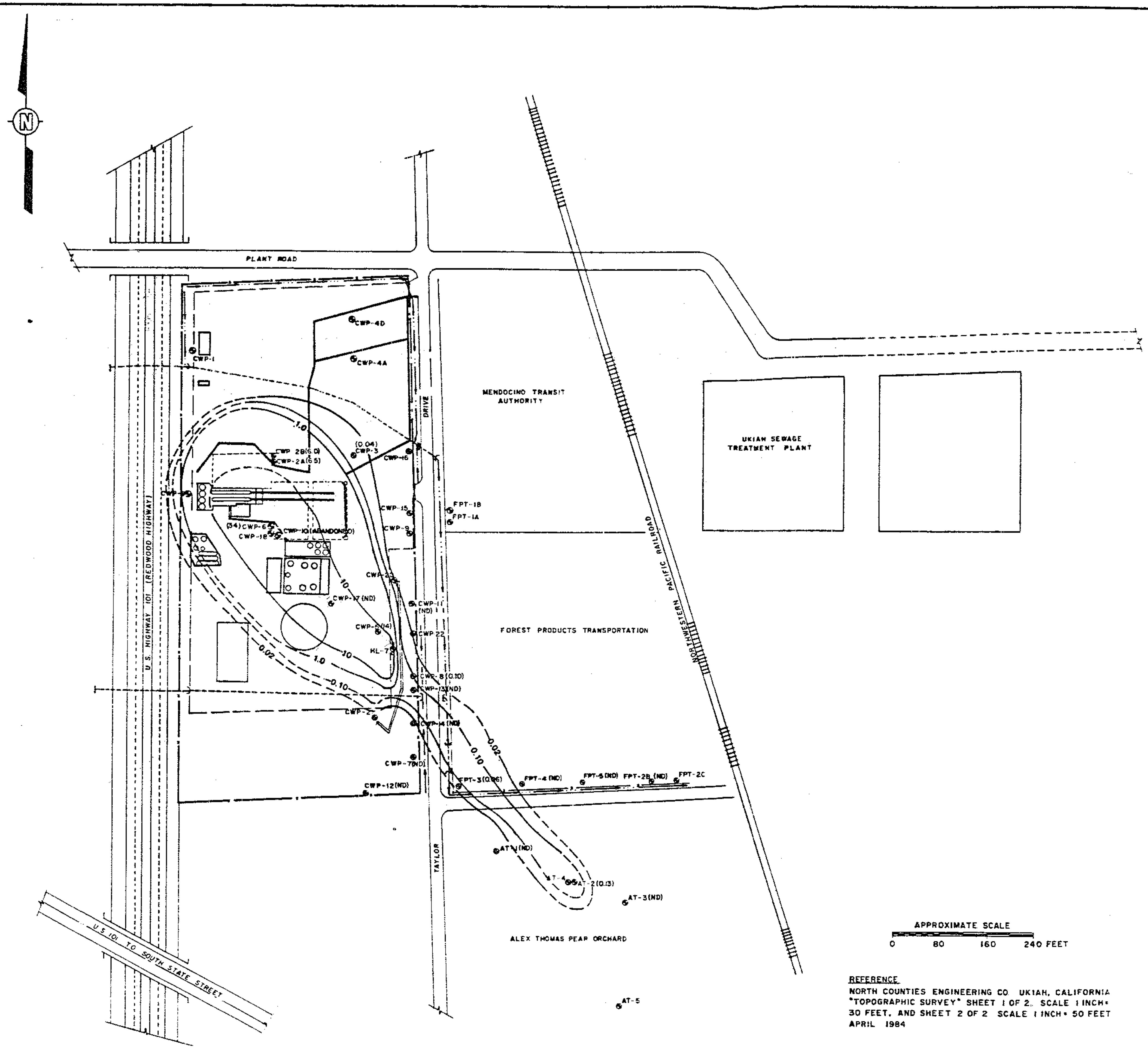
FIGURE II

SOIL SAMPLING LOCATIONS AND APPROXIMATE EXTENT OF ARSEN & CHROMIUM IN NEAR-SURFACE SOIL

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM



LEGEND:

- MONITORING WELL, DISSOLVED TOTAL CHROMIUM CONCENTRATION SHOWN IN PPM. ND DENOTES NOT DETECTED, DETECTION LIMIT 0.02 PPM
- 0.10 — CHROMIUM ISOCONCENTRATION (PPM), DASHED WHERE APPROXIMATE

APPROXIMATE SCALE
0 80 160 240 FEET

REFERENCE
NORTH COUNTIES ENGINEERING CO. UKIAH, CALIFORNIA "TOPOGRAPHIC SURVEY" SHEET 1 OF 2. SCALE 1 INCH = 30 FEET, AND SHEET 2 OF 2 SCALE 1 INCH = 50 FEET APRIL 1984

FIGURE 12

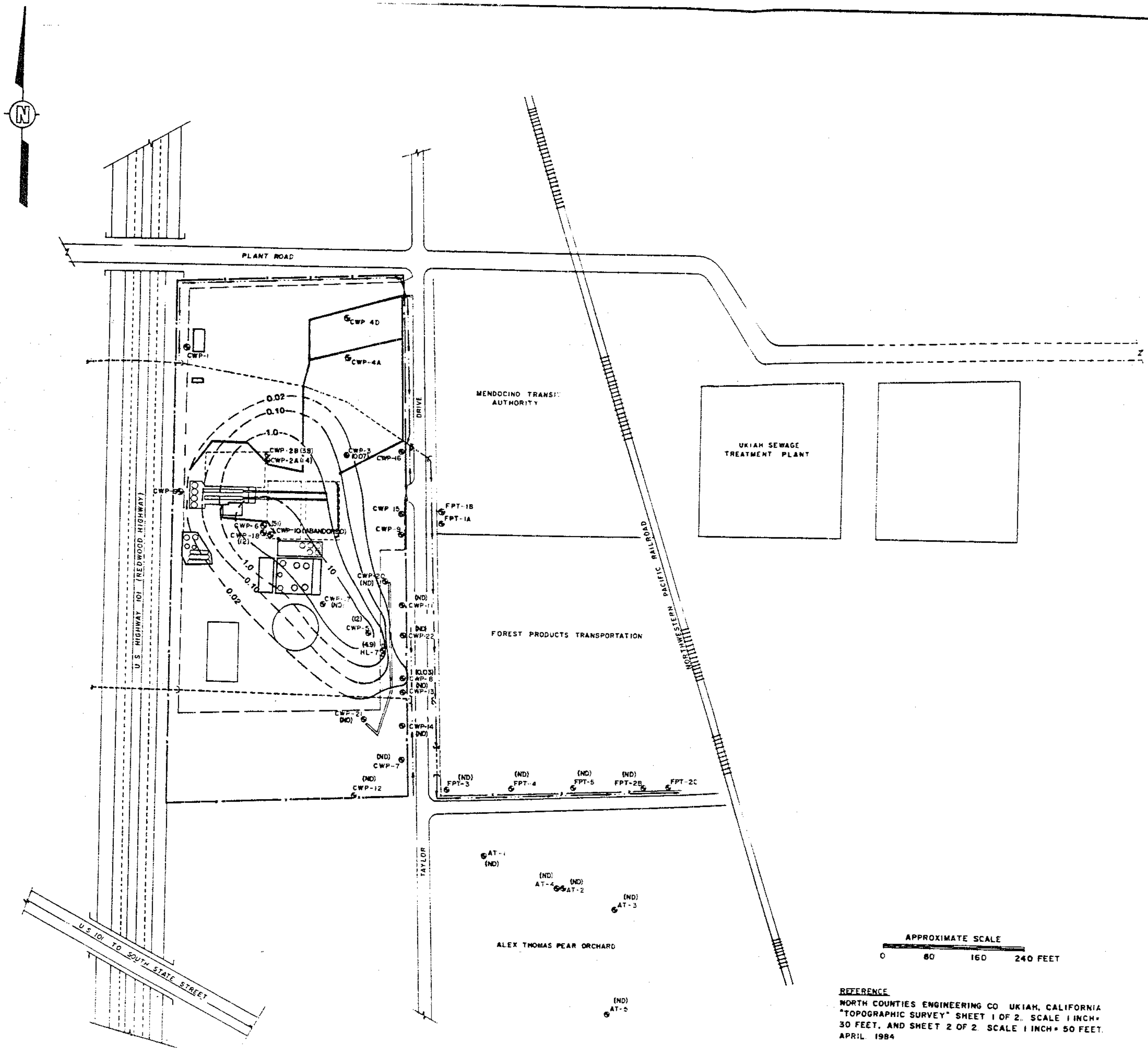
DISSOLVED TOTAL CHROMIUM ISOCONCENTRATIONS JANUARY/FEBRUARY 1986

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	SHS 7-31-87	CHECKED BY	2-3-89	DRAWING NUMBER	86-113-E4
		APPROVED BY	H. Mehran 2-3-89		



LEGEND:

MONITORING WELL. DISSOLVED TOTAL CHROMIUM CONCENTRATION SHOWN IN PPM. ND DENOTES NOT DETECTED DETECTION LIMIT 0.02 PPM

—0.10— CHROMIUM ISOCONCENTRATION (PPM) DASHED WHERE APPROXIMATE

APPROXIMATE SCALE
0 80 160 240 FEET

REFERENCE
NORTH COUNTIES ENGINEERING CO. UKIAH, CALIFORNIA "TOPOGRAPHIC SURVEY" SHEET 1 OF 2. SCALE 1 INCH = 30 FEET, AND SHEET 2 OF 2. SCALE 1 INCH = 50 FEET. APRIL 1984

FIGURE 13

DISSOLVED TOTAL CHROMIUM ISOCONCENTRATIONS
APRIL 1987

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

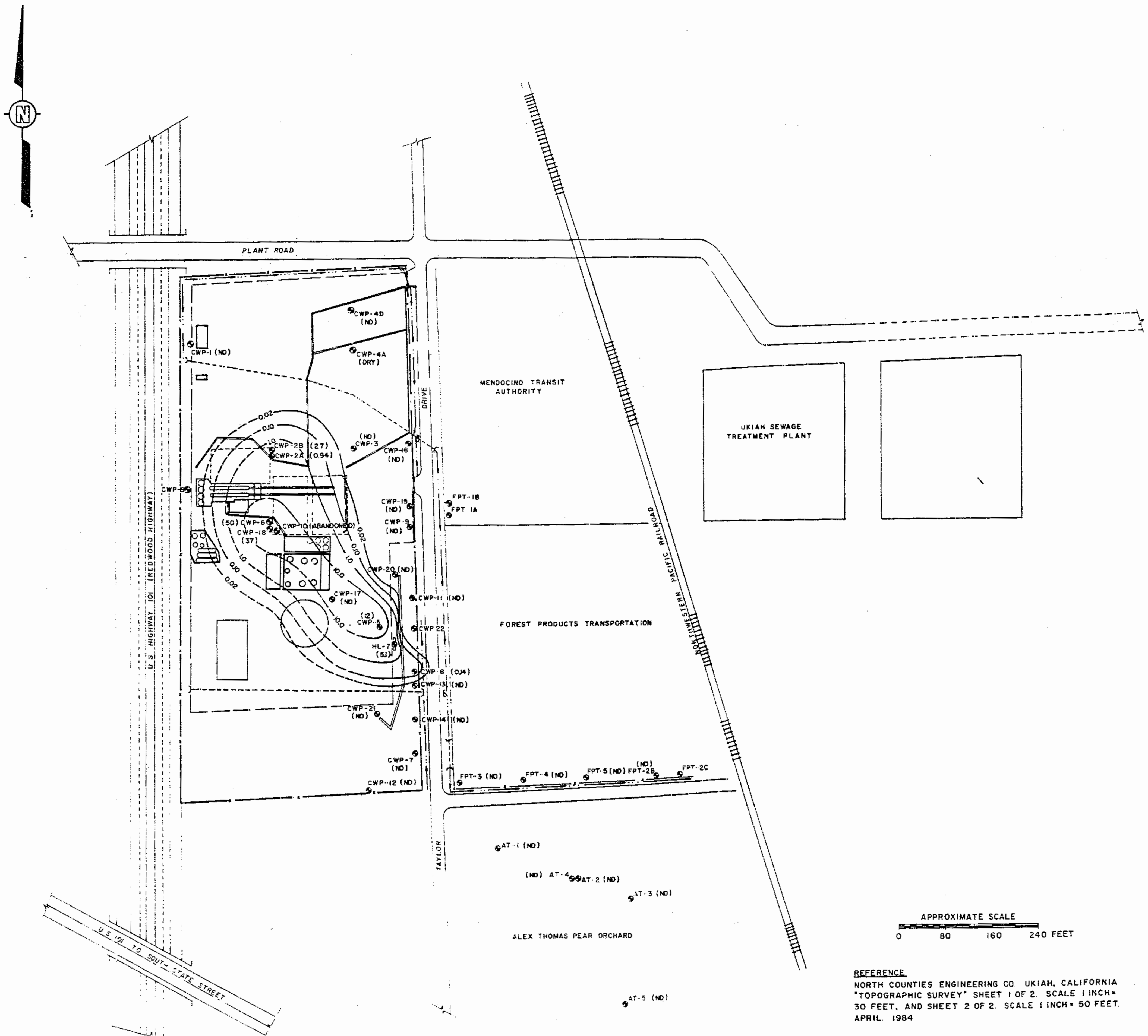
GEOSYSTEM

DRAWN BY	SHS 7-31-87	CHECKED BY	2-3-87	DRAWING NUMBER 86-113-E5
		APPROVED BY	2-3-89	

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
KL Bui, Sept 1988	2-3-1989	2-3-1989	86-113-E8

LEGEND

- MONITORING WELL, DISSOLVED TOTAL CHROMIUM CONCENTRATION SHOWN IN PPM. "ND" DENOTES NOT DETECTED. DETECTION LIMIT 0.02 PPM.
- CHROMIUM ISOCONCENTRATION (PPM) DASHED WHERE APPROXIMATE



REFERENCE
NORTH COUNTIES ENGINEERING CO. UKIAH, CALIFORNIA "TOPOGRAPHIC SURVEY" SHEET 1 OF 2. SCALE 1 INCH = 30 FEET, AND SHEET 2 OF 2. SCALE 1 INCH = 50 FEET. APRIL 1984

FIGURE 14

DISSOLVED TOTAL CHROMIUM ISOCONCENTRATIONS

JANUARY, 1988

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
DCH 1-25-89	[illegible] 2-3-89	M. Mehran 2-3-89	86113-A5

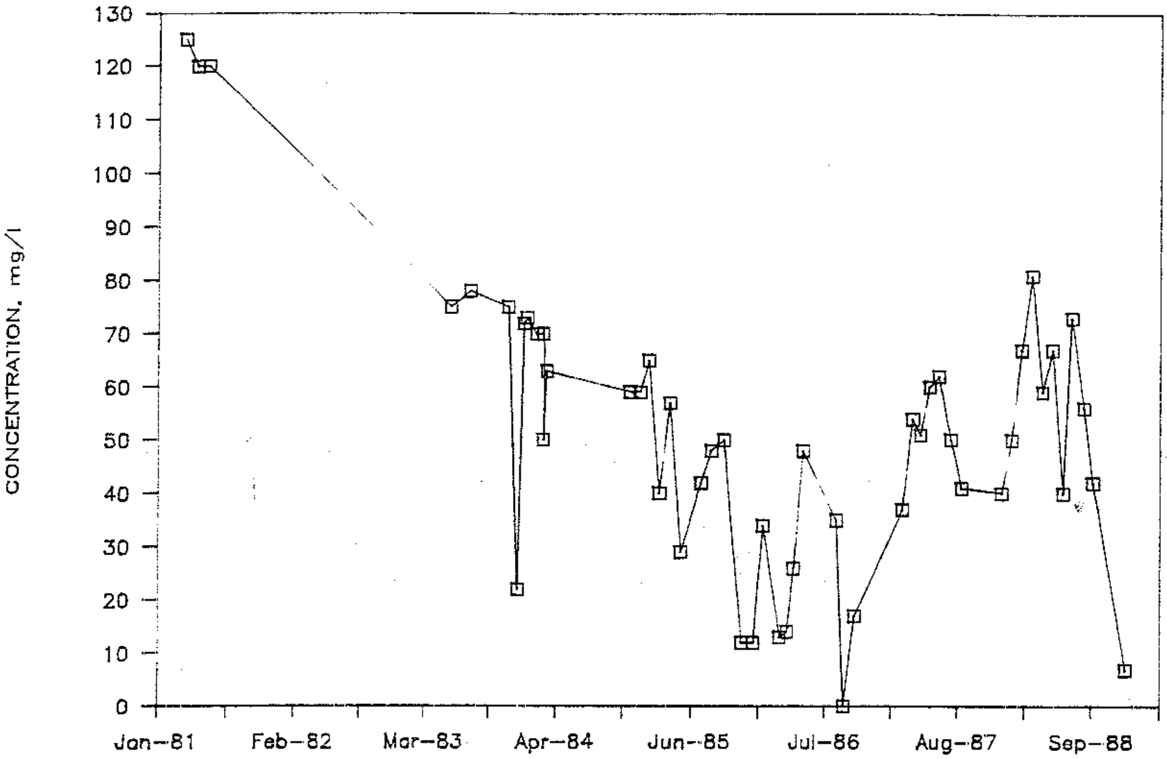


FIGURE 15

DISSOLVED TOTAL CHROMIUM
VERSUS TIME
CWP-6

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	DCH	1-25-89
CHECKED BY	[illegible signature]	2-3-89
APPROVED BY	H. Mahran	2-3-89
DRAWING NUMBER	86113-A6	

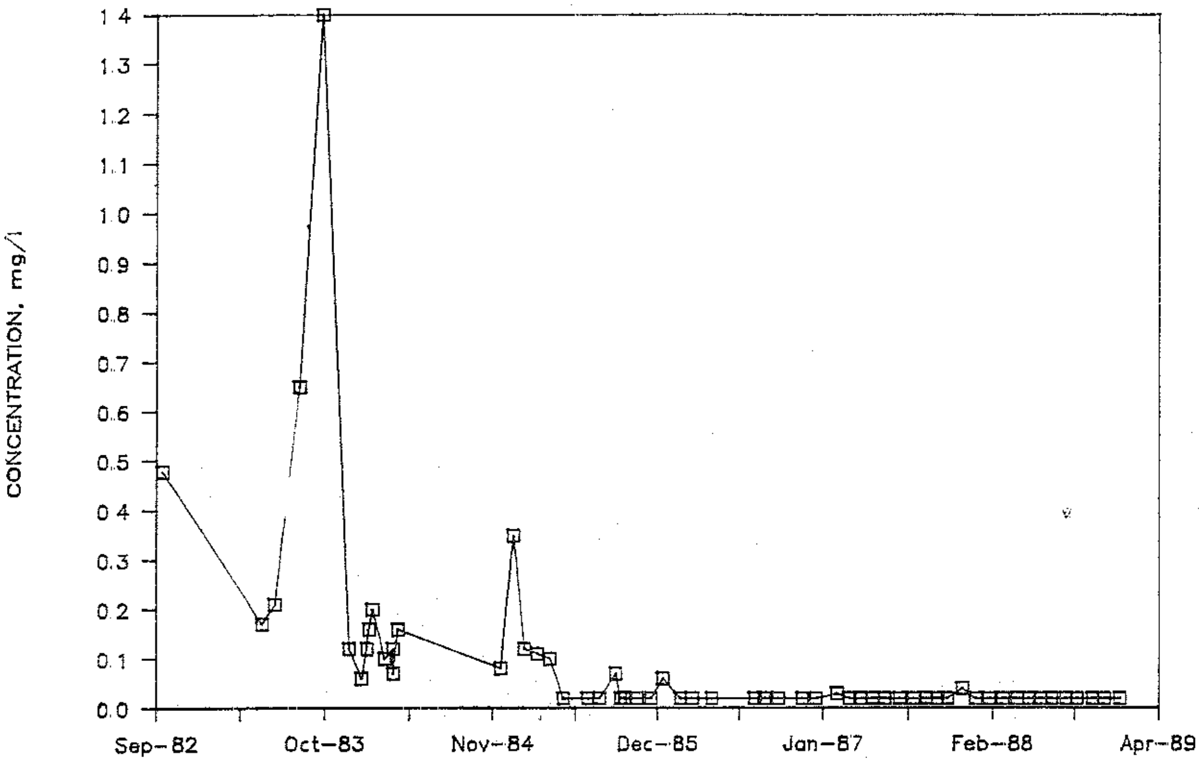


FIGURE 16

DISSOLVED TOTAL CHROMIUM
VERSUS TIME
FPT-3

PRELIMINARY

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY DCH 1-25-89

CHECKED BY 2-3-89

APPROVED BY 2-3-89

DRAWING NUMBER 86113-A7

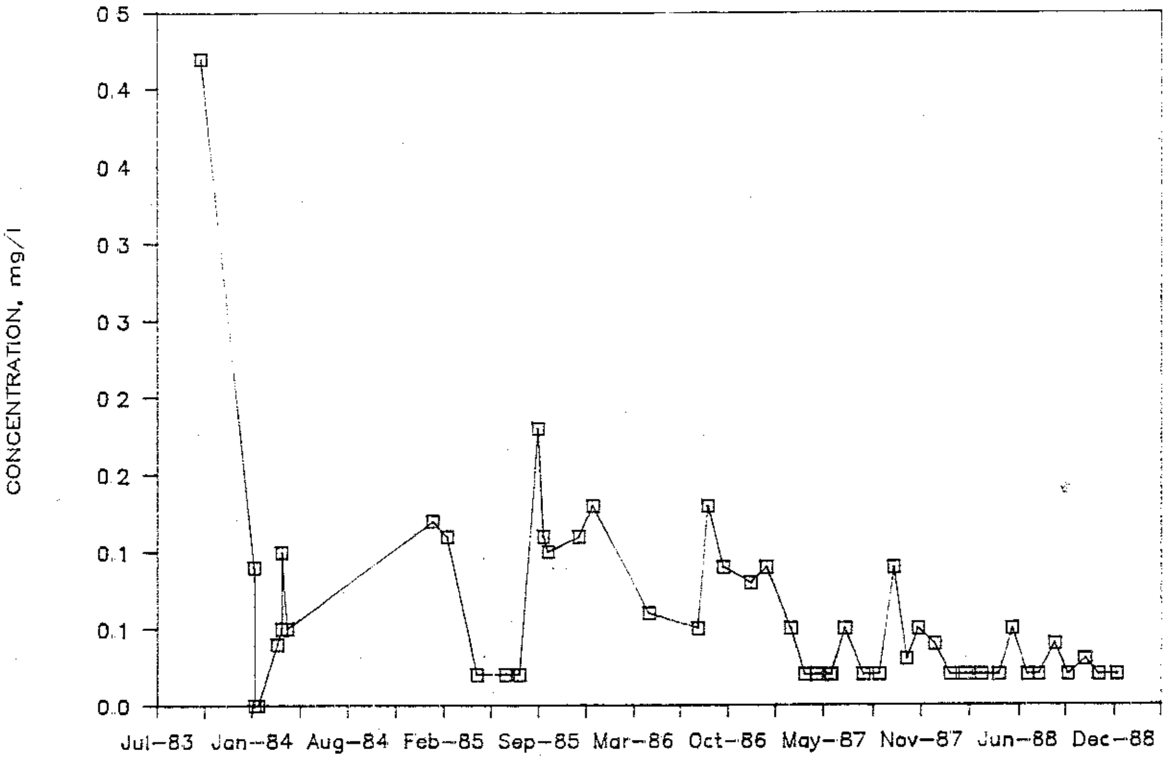


FIGURE 17

DISSOLVED TOTAL CHROMIUM
VERSUS TIME
AT-2

PRELIMINARY

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

GEOSYSTEM

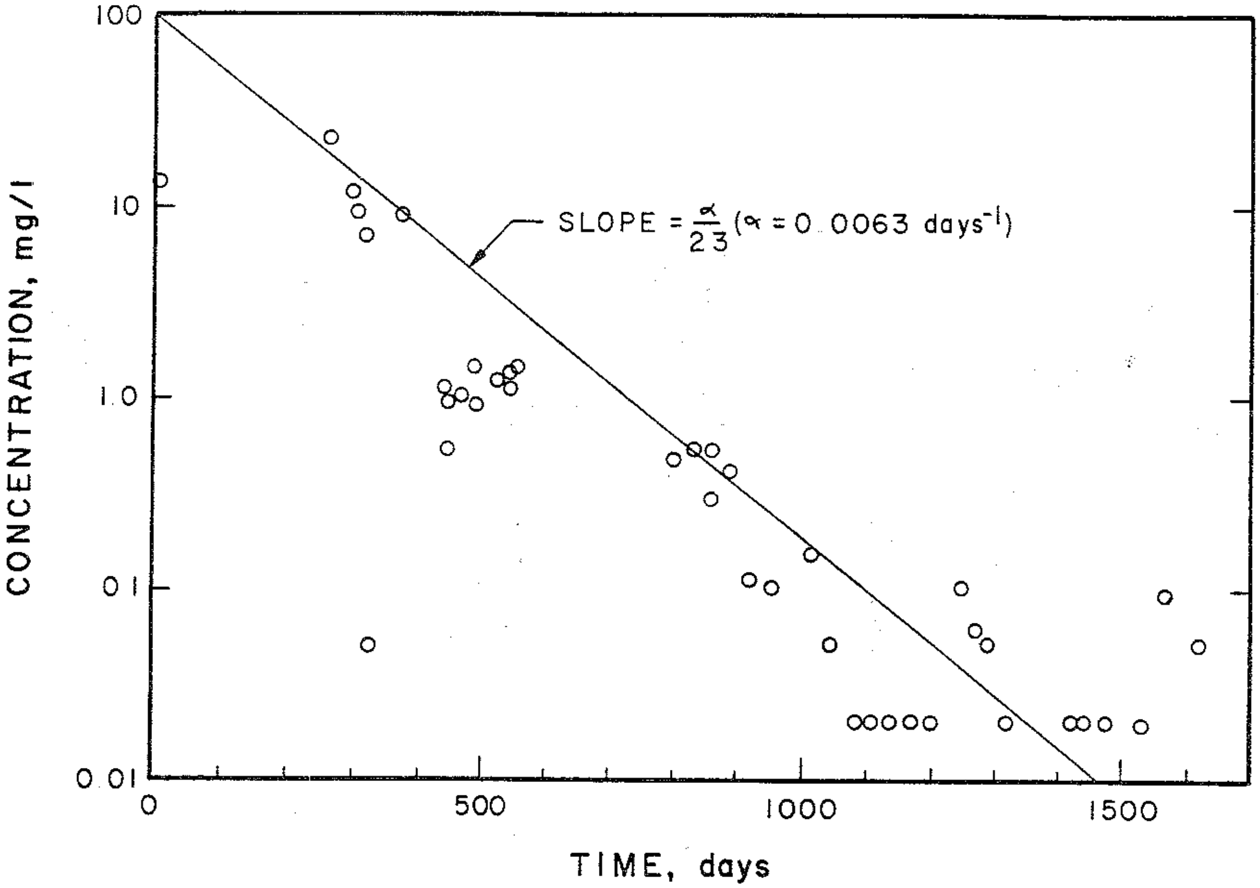


FIGURE 18

DISSOLVED TOTAL CHROMIUM
VERSUS TIME, WELL CWP-8

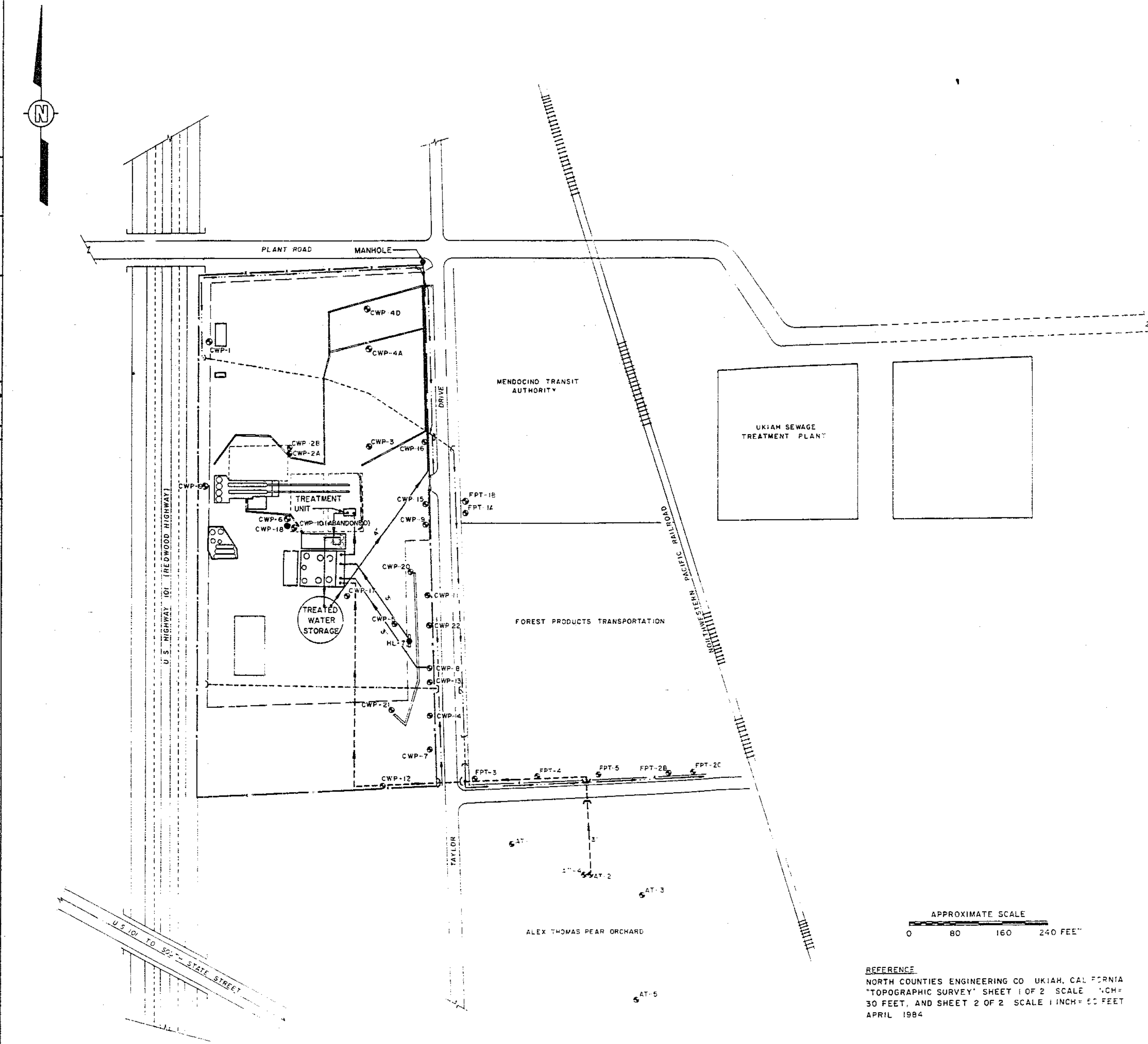
PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	SHS 7-31-87	CHECKED BY	2-3-89	DRAWING NUMBER 86-113-A3
		APPROVED BY	M. Mohren 2-3-89	

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
MBM, Sept 1988	2-3-1989	2-3-1989	86-113-E9



LEGEND

- ● EXTRACTION WELL
- MONITORING WELL
- 3" EXISTING PIPELINE SHOWING DIAMETER AND DIRECTION OF FLOW
- 3" CONTINGENCY PIPELINE FOR POSSIBLE OFF-SITE REMEDIATION, SHOWING DIAMETER AND DIRECTION OF FLOW

REFERENCE
NORTH COUNTIES ENGINEERING CO. UKIAH, CALIFORNIA "TOPOGRAPHIC SURVEY" SHEET 1 OF 2 SCALE 1 INCH = 30 FEET, AND SHEET 2 OF 2 SCALE 1 INCH = 50 FEET
APRIL 1984

FIGURE 19

GROUND WATER EXTRACTION / TREATMENT SYSTEM FLOW DIAGRAM

PRELIMINARY

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

APPENDIX A

CHRONOLOGY

DRAFT

APPENDIX A

CHRONOLOGY[1]

1971	Coast Wood Preserving, Inc. (CWP) begins wood preserving operations at the site.
January 31, 1972	The County raises questions about the discharge of chemical preservatives from the CWP site via rainwater runoff.
February 23, 1972	The Department of Fish and Game (DFG) notifies the California Regional Water Quality Control Board, North Coast Region (RWQCB) that wood preservatives are being discharged from the CWP site to the Russian River.
March 28, 1972	RWQCB staff request a report of waste discharge from CWP.
April 17, 1972	The RWQCB Executive Officer issues Cleanup and Abatement Order No. 72-29 to CWP.
April 26, 1972	The RWQCB adopts Order No. 72-22 which includes Waste Discharge Requirements for the CWP site.
May 1, 1972	Because of non-compliance, the RWQCB Executive Officer requests that the Attorney General petition the court to issue an injunction requiring immediate compliance with Order No. 72-29.
	RWQCB staff request that CWP store treated wood on asphalt-paved surfaces during the winter months.
January 9, 1973	Court orders CWP to install storage facilities to contain contaminated rainwater, originating from the wood storage area, by January 15, 1973.
January 15, 1973	CWP complies with court order.
March 25, 1974	RWQCB staff requests a spill contingency plan pursuant to Order No. 74-38.

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May 2, 1975	The RWQCB Executive Officer rescinds Cleanup and Abatement Order No. 72-29.
April 4, 1979	RWQCB staff observe CWP's expansion activities and request a new report of waste discharge.
May 24, 1979	CWP indicates that no wastes are discharged; therefore, a report of waste discharge is not applicable.
April 17, 1980	Public concerns are expressed through RWQCB about wastes being discharged from the CWP facility.
June 13, 1980	RWQCB staff inspect the CWP facility and identify the potential for ground water and surface water contamination. Surface water samples are collected.
August 6, 1980	Sampling results indicate wood preserving chemicals may be contaminating ground water.
September 16, 1980	RWQCB staff request a technical report to determine the cause of the surface discharge and the extent of contamination, including that in ground water.
October 28, 1980	CWP requests a meeting to discuss the RWQCB's evaluation of potential contamination.
	CWP seeks professional consulting services.
November 17, 1980	RWQCB staff meet with CWP representatives who request an extension to the deadline for developing the technical report.
	RWQCB staff identify the northeast portion of the facility as the area of key concern.
November 21, 1980	RWQCB staff sample runoff from treated wood on asphalt near culvert.

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November 25, 1980	RWQCB staff extends deadline for receipt of proposal for technical report until December 17, 1980.
November 26, 1980	The results of analyses of storm water samples, collected by RWQCB staff on November 21, 1980, indicate the presence of wood preserving chemicals.
December 15, 1980	CWP provides technical study proposal requested on September 16, 1980.
January 14, 1981	RWQCB staff request that the study proposal be expanded to include sampling of surface flow and storm water runoff.
February 9, 1981	Laboratory results of storm water and stream water samples collected by RWQCB staff on January 23, 1981 reveal continued discharge.
	RWQCB staff meet with CWP's consultant on technical study and indicate need for early results of monitoring.
February 20, 1981	RWQCB staff notices a Cease and Desist hearing.
March 20, 1981	RWQCB staff obtain storm water discharge samples from CWP which indicate that elevated levels of chromium, copper, and arsenic are being discharged during rainfall events.
March 10 & 24, 1981	Draft RWQCB Cease and Desist Order requirements, including measures for control of ground water and storm water discharges, are forwarded to CWP.
March 19 and 20, 1981	H. Esmaili & Associates, Inc. (HEA) installs ground water monitoring wells CWP-1 through CWP-6.
March 26, 1981	RWQCB adopts Cease and Desist Order No. 81-61, requiring CWP to cease the discharge of wood preservatives to ground and surface waters no later than September 15, 1981.

April 10, 1981	CWP submits information to the RWQCB in partial compliance with the first task of the Cease and Desist Order, requiring implementation of interim pollution control measures.
April 20, 1981	Preliminary monitoring results from Wells CWP-1 through CWP-6 indicate ground water contamination by chromium.
April 27, 1981	CWP approaches the City of Ukiah (the City) for permit to discharge untreated wastewater to sanitary sewer system.
April 29, 1981	CWP submits information to the RWQCB in partial compliance with that portion of the Cease and Desist Order requiring proposals or remedies for storm water discharge control.
May 15, 1981	RWQCB staff meet with CWP and tentatively agree on control measures. RWQCB staff indicate that discharge to sewage treatment plant without pre-treatment is not feasible.
May 28, 1981	The City refuses to accept CWP wastewater in sanitary sewer system.
June 12, 1981	RWQCB staff are informed, in a meeting with CWP, that previously proposed control measures cannot be implemented and an alternative, ion exchange, method for wastewater treatment is being considered. RWQCB staff ask for a plan.
June 25, 1981	RWQCB staff ask that a plan on ion exchange wastewater treatment process be submitted by July 6.
July 6, 1981	CWP does not submit requested plan.
July 22, 1981	The RWQCB again requests plan for wastewater treatment, to be received within 10 days of RWQCB letter. RWQCB also reminds CWP of the September 15, 1981 deadline, whereby all ground water and surface water discharge must be eliminated.

August 6, 1981	The RWQCB receives letter from CWP providing a brief description of the ion exchange process. RWQCB staff judge this submittal to be an insufficient plan. CWP indicates it intends to meet the September 15, 1981 deadline.
August 26, 1981	HEA issues report entitled "Investigation of Ground Water Pollution."
August 28, 1981	CWP finds ion-exchange wastewater treatment process is inefficient in testing. CWP proposes a new interim measure to control and treat contaminated storm water, but does not provide full details to the RWQCB.
September 14, 1981	CWP provides results of HEA ground water study to RWQCB staff which indicate contamination by hexavalent chromium.
September 15, 1981	RWQCB staff judge that the measures implemented to prevent discharge of wood preserving chemicals to soil, storm water, and ground water are inadequate and refer the case to the Attorney General.
September 22, 1981	RWQCB staff meet with CWP to specify their informational needs. The information is to be provided by October 1, 1981.
	CWP proposes ground water extraction wells along the eastern site boundary.
September 24, 1981	CWP indicates in a telephone conversation with RWQCB staff that the technical information requested on September 22, 1981 is being submitted.
September 28, 1981	RWQCB staff outline CWP's responsibilities in a letter.
October 2, 1981	CWP submits a plan to RWQCB. Plan is judged inadequate by RWQCB.
October 12, 1981	CWP submits revised plan to RWQCB.

October 19, 1981	RWQCB staff send letter to CWP detailing plan inadequacies.
	CWP installs extraction wells CWP-7, CWP-8, and CWP-9.
November 9, 1981	RWQCB staff install off-site monitoring wells (FPT-1A, FPT-1B, FPT-2A, and FPT-3) some of which confirm off-site ground water contamination.
November 11, 1981	CWP ceases the discharge of ground water from extraction wells to surface drainage ditches at the request of the Attorney General.
November 17, 1981	CWP meets with RWQCB staff and presents plans; RWQCB outlines needs for more information and timely action.
November 20, 1981	CWP submits new plan.
December 1 - 18, 1981	RWQCB and Deputy Attorney General determine that threat of discharge to the Russian River exists.
December 18, 1981	Court issues preliminary injunction at Deputy Attorney General's request incorporating CWP's proposals of November with agency modifications.
January 13, 1982	RWQCB staff send letter to CWP pointing out delays and urging timely effort in ground water investigation; RWQCB staff suggest a meeting to help resolve any questions.
January 28, 1982	CWP's legal counsel sends letter to Deputy Attorney General indicating plans for further investigation. Indicates concern that RWQCB staff is involved with issues outside their jurisdiction.
February 10, 1982	Deputy Attorney General, representing the RWQCB, contacts CWP by telephone requesting more information on progress.
	CWP sends letter detailing recent activities.

February 24, 1982	Deputy Attorney General sends letter to CWP expressing concern with lack of progress and insufficient compliance with RWQCB orders.
March 24, 1982	CWP provides exploratory drilling plan without technical support information.
April 6, 1982	RWQCB transmits draft Waste Discharge Requirements to CWP.
April 16, 1982	CWP requests consideration of the draft Waste Discharge Requirements be postponed until the next Board Meeting.
April 26, 1982	RWQCB staff agree to postpone consideration of the requirements until the July Board Meeting.
June 30, 1982	CWP submits Kleinfelder Phase II plan.
July 6, 1982	RWQCB staff send letter on deficiencies in self-monitoring of ground and surface waters.
	CWP provides comments on draft Waste Discharge Requirements.
July 22, 1982	Board adopts new Waste Discharge Requirements for CWP.
July 26, 1982	Deputy Attorney General, representing RWQCB, sends comments to CWP on Kleinfelder Phase II plan.
August 26/27/30, 1982	Kleinfelder installs four monitoring wells (CWP-10, CWP-11, CWP-12, and CWP-13).
September 15 & 16, 1982	Kleinfelder installs three additional monitoring wells (CWP-14, CWP-15, and CWP-16); soil samples are collected.
September 29, 1982	CWP sends progress report on investigation and revises spill contingency plan.
November 2, 1982	RWQCB staff send comments related to inadequacy of submittals.

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November 16, 1982	RWQCB staff and the Deputy Attorney General meet with CWP and their consultant to discuss modification of preliminary injunction.
December 3, 1982	Kleinfelder submits "Report for Phase II Groundwater Study."
	Deputy Attorney General, representing RWQCB, sends letter to CWP summarizing the November 16, 1982 meeting and requesting that several actions be taken.
December 27, 1982	Deputy Attorney General, representing RWQCB, sends comments on Kleinfelder report.
December 27, 1982	CWP sends a letter in response to Deputy Attorney General's letter of December 3.
December 31, 1982	RWQCB issues press release on the inclusion of the CWP site on the new federal and state Superfund list.
January 7, 1983	RWQCB staff meet with CWP, who agree to install additional off-site wells and take other actions.
January 14, 1983	CWP requests modification of Waste Discharge Requirements to permit discharge of extracted ground water to sanitary sewer system.
January 18, 1983	RWQCB staff reply to the January 14, 1983 request, indicating their position on no discharge to surface waters or ground waters and indicating the need to modify the City's permit if treated wastewater from the CWP facility is accepted.
	RWQCB staff send letter indicating need for submittal of information, now past due, discussed at the meeting.
February 4, 1983	CWP replies, stating that evaluation of alternatives and work are in progress.

March 11, 1983	Kleinfelder submits report on "Soil Chemical Analysis Results." [RWQCB indicates no such report on file.]
May 16, 1983	Deputy Attorney General, representing RWQCB, sends letter requesting immediate installation of the agreed upon two off-site wells, as previously requested.
June 2, 1983	CWP installs off-site wells (FPT-4 and FPT-5).
June 8, 1983	CWP letter reports construction details of Wells FPT-4 and FPT-5, but provides inadequate response on other issues.
July 16, 1983	RWQCB staff send necessary forms for filing a new report of waste discharge, per CWP request.
July 19, 1983	CWP submits brief report on installation of Wells FPT-4 and FPT-5.
July 27, 1983	Kleinfelder submits report titled "Recommendations for Pumping Program at Well CWP-8." [RWQCB indicates no such report on file.]
August 9, 1983	Deputy Attorney General, representing RWQCB, sends letter regarding receipt of reports, and informs CWP that their response to RWQCB orders has been inadequate.
	Control measures to contain contaminated stormwater are implemented.
August 22, 1983	CWP responds to Deputy Attorney General letter of August 9, 1983.
	CWP informs RWQCB staff of the planned construction of a bentonite slurry cutoff wall to prevent or retard off-site migration of chromium-contaminated ground water.
September 2, 1983	RWQCB staff meet with CWP and discuss needed actions. CWP indicates plans to install cutoff wall; RWQCB indicates that these activities should be

	conducted by a professional in the field of hydrogeology.
September 9, 1983	Kleinfelder installs three additional monitoring wells (AT-1, AT-2, and AT-3) off site at locations recommended by RWQCB staff.
September 15, 1983	CWP sends letter report to RWQCB.
September 26, 1983	Kleinfelder submits "Groundwater Monitoring Well Construction" report.
October 6, 1983	Deputy Attorney General, representing RWQCB, sends letter to CWP regarding need for professional hydrogeologist to design and supervise construction of cutoff wall.
October 13, 1983	RWQCB issues Cleanup and Abatement Order No. 83-128 because of delays and failure to use professional assistance in determining needed remedial actions.
October 20, 1983	CWP responds to Deputy Attorney General letter of October 6, indicating that they see no need for professional oversight.
October 25, 1983	CWP requests a full review of the cleanup and abatement order before the Board.
November 18, 1983	CWP informs RWQCB staff that cutoff wall was installed, without professional oversight.
December 23, 1983	RWQCB staff respond to November 18, 1983 letter from CWP.
January 5, 1984	CWP applies for permit to discharge treated wastewater to the City's sanitary sewer system.
January 6, 1984	CWP responds to RWQCB's December 23 letter.
January 19, 1984	RWQCB hearing is held on the Cleanup and Abatement order, which is subsequently ratified.

January 31, 1984	RWQCB staff re-transmit ratified order and require immediate compliance.
	CWP submits D'Appolonia work plan entitled "Investigation of Chromium in Soil" to DHS for review.
February 7, 1984	CWP informs RWQCB staff that they have hired a consultant to conduct the soil and ground water investigation, and that they fully intend to comply with the Board orders.
February 17, 1984	The City retains a consultant to review the proposed discharge of treated wastewater from CWP.
February 28, 1984	CWP submits revised D'Appolonia work plan for investigation of chromium in soil.
March 19, 1984	D'Appolonia conducts soil quality investigation, including Borings S-1 through S-26.
	The City's consultant recommends acceptance of treated wastewater into the sanitary sewer system.
April 1984	CWP hires Alpha Lab to perform baseline analysis of the City's sanitary sewer discharge.
May 1, 1984	D'Appolonia issues report entitled "Investigation of Chromium in Soil."
May 3, 1984	CWP submits work plan for determining full extent of ground water contamination by hexavalent chromium.
May 24, 1984	RWQCB staff comment on the needed modifications to the May 3, 1984 work plan.
May 29, 1984	RWQCB, DHS, and EPA meet with CWP to discuss further needed actions. A report is required by June 22, 1984.

June 5, 1984	EPA informs RWQCB of requirements for cleanup of Superfund sites.
June 20, 1984	On behalf of CWP, D'Appolonia submits a letter report on progress and proposed interim site remediation.
	RWQCB transmits EPA's concerns regarding Superfund requirements to CWP.
July 3, 1984	RWQCB and other agency staff meet with CWP and D'Appolonia to discuss the May 3 and June 20 submittals.
July 6, 1984	RWQCB staff send letter outlining agreements reached and requirements identified at the July 3 meeting.
July 18, 1984	RWQCB staff comment on D'Appolonia's June 20, 1984 proposal and suggest a few minor modifications.
August 1, 1984	D'Appolonia responds, on behalf of CWP, to the July 18 RWQCB letter.
October 4, 1984	D'Appolonia submits status report on behalf of CWP.
November 2, 1984	D'Appolonia submits status report on behalf of CWP.
December 10, 1984	D'Appolonia submits status report on behalf of CWP.
January 15, 1985	Deep Boring S-27 drilled and converted to Well CWP-17.
April 5, 1985	RWQCB staff meet with CWP and other regulatory agencies.
April 15, 1985	RWQCB staff send letter outlining points of agreement reached at meeting and the clarification which is needed.
May 29, 1985	RWQCB staff meet with CWP and other regulatory agencies.
June 4, 1985	RWQCB staff send letter to CWP summarizing meeting and needed actions.

June 26, 1985	CWP submits "Hydrologic and Remedial Action Feasibility Studies" report to all agencies.
July 25, 1985	RWQCB re-issues Waste Discharge Requirements for CWP, with modifications for treated ground water reinjection.
July 29, 1985	RWQCB staff and agencies meet with CWP on the revised report submitted on July 10, 1985.
August 23, 1985	Based on the comments of all the reviewing agencies, RWQCB staff send letter to CWP identifying additional information needed.
August 29 and 30, 1985	Wells CWP-18, CWP-19, CWP-20, and CWP-21 are constructed at the site.
September 27, 1985	IT Corporation submits report entitled "Remedial Action Implementation Schedule."
March 20, 1986	RWQCB staff indicate that sampling techniques should be improved and that CWP has failed to submit a sampling protocol as previously requested in 1981 and 1982.
March 31, 1986	On behalf of CWP, Geosystem submits report on "Evaluation of On-Site Ground Water Extraction."
April 30, 1986	CWP sends letter to RWQCB indicating that no sampling protocol is available and requesting a discussion of the matter with staff.
June 12, 1987	DHS receives EPA comments on "Evaluation of On-Site Ground Water Extraction," submitted on March 31, 1986.
June 13, 1986	RWQCB and other agencies meet with CWP and Geosystem to discuss further efforts required at CWP.
June 19, 1986	DHS sends letter to CWP regarding requirements for preparation of a Remedial Action Plan (RAP).

June 20, 1986	RWQCB staff summarize meeting of June 13, 1986 and request the submittal of sampling plan and other information.
	EPA sends letter to Geosystem identifying the need for further evaluation of leachability of chromium from soil at CWP.
June 25, 1986	On behalf of CWP, Geosystem submits draft Ground Water Monitoring Protocol to RWQCB.
July 21, 1986	CWP receives comments from RWQCB staff on draft Ground Water Monitoring Protocol.
August 21, 1986	RWQCB staff remind CWP in a letter of the need for prompt action on previous requests.
August 28, 1986	Geosystem submits Ground Water Monitoring Protocol and a timeframe for obtaining additional information.
August 29, 1986	Geosystem submits progress report which addresses issues outlined in June 20, 1986 letter from RWQCB.
September 4, 1986	CWP indicates that they misread the deadline and promptly comply.
September 15, 1986	Geosystem submits pre-draft RAP.
September 19, 1986	DHS transmits sample deed restriction to CWP and explains annuity requirement.
	Geosystem issues draft report on "Definition and Hydraulic Control of Chromium in Ground Water."
October 28, 1986	RWQCB staff and agencies meet with CWP to discuss draft RAP. DHS issues comments on pre-draft RAP.
November 4, 1986	RWQCB staff re-issue the Cleanup & Abatement Order and set out several needed tasks.

November 13, 1986	CWP submits plan for needed activities.
	Geosystem submits letter report on Additional Site Characterization, addressing Item 1.a of Revised Cleanup and Abatement Order No. 83-128.
November 21, 1986	RWQCB staff comment on the locations of the monitoring wells proposed in the drilling plan.
	Geosystem submits letter report on Soil Leaching Characteristics and Duration of Aquifer Cleanup.
December 2, 1986	Geosystem issues progress report.
December 9-11, 1986	Geosystem installs new monitoring wells (CWP-22, AT-4, and AT-5). RWQCB staff are present during well installation.
December 19, 1986	CWP requests modifications to monitoring program.
	CWP sends comments to RWQCB regarding Revised Monitoring and Reporting Program No. 85-101.
January 9, 1987	EPA issues comments on CWP letter reports dated November 13 and 21, 1987.
	Geosystem submits report on "Monitoring Well Installation and Additional Site Characterization," which documents the installation and sampling of additional wells (CWP-22, AT-4, and AT-5).
January 27, 1987	Geosystem submits progress report.
February 23, 1987	CWP requests extension of Cleanup & Abatement Order deadline from March 1 to April 1, 1987.
March 4, 1987	RWQCB staff grant CWP's request for an extension.
March 24, 1987	EPA issues comments on pre-draft RAP and "Monitoring Well Installation and Additional Site Characterization."

March 25, 1987	DHS transmits to CWP "Draft Guidelines for the Remedial Action Plan - Re-revised" (February 18, 1987) and additional comments on pre-draft RAP.
March 31, 1987	DHS notifies CWP of May 1, 1987 date for submission of draft RAP.
April 1, 1987	Geosystem submits report on "Evaluation of Off-Site Remediation" in response to Item 1.d of Revised Cleanup & Abatement Order No. 83-128.
April 14, 1987	CWP submits Hydrologic Remediation Plan.
	Geosystem submits time schedule for remedial actions.
April 29, 1987	Geosystem issues a review of regulatory agencies comments.
April 30, 1987	CWP submits "Proposed Discharge of Treated Groundwater to City of Ukiah Sewage Treatment Plant" report to the City. City responds with various items.
May 12, 1987	RWQCB and other agency staff meet with CWP and Geosystem personnel
May 29, 1987	RWQCB staff send letter to CWP outlining needed actions.
	Geosystem issues progress report.
June 10, 1987	CWP responds to RWQCB letter of May 29, 1987.
June 17, 1987	Geosystem requests extension of deadline for submission of draft RAP to July 31, 1987.
	CWP meets with the City regarding discharge of treated ground water to treatment plant; the City requests further information.
July 10, 1987	DHS sends CWP the EPA's comments on Remedial Investigation/Feasibility Study efforts and grants extension of deadline

	for submission of draft RAP from June 30 to July 31, 1987.
July 16, 1987	Geosystem submits response to EPA comments (as forwarded by DHS on July 10, 1987).
July 31, 1987	Draft RAP submitted by Geosystem to all agencies.
August 7, 1987	Geosystem submits revised Ground Water/ Storm Water Monitoring Protocol.
August 19, 1987	CWP meets with Ukiah Sewage Treatment Plant personnel. The City requests further information.
August 24, 1987	The City drafts monitoring program.
September 10, 1987	RWQCB issues comments on draft RAP.
September 17, 1987	Letter from CWP to the City outlining discussions of the August 19, 1987 meeting and indicating that the additional information requested is being pursued.
September 18, 1987	Geosystem issues progress report.
September 24, 1987	DHS issues comments on draft RAP and forwards DHS and EPA comments to Geosystem.
September 29, 1987	Geosystem receives table of contents for the new RAP policy.
October 7, 1987	The City gives verbal approval for discharge to sanitary sewer system. City attorney to draft documents.
October 14, 1987	Geosystem issues progress report.
November 3, 1987	Geosystem submits draft Chronology to RWQCB staff for review and comment.
November 13, 1987	Geosystem issues progress report.
November 24, 1987	RWQCB staff issues comments on draft Chronology.

November 30, 1987	Geosystem submits second draft Chronology to RWQCB for review and comment. Geosystem submits "Proposed Response Approach to Regulatory Agencies Comments" to CWP and agencies.
December 7, 1987	RWQCB staff issues comments on second draft Chronology.
December 14, 1987	Geosystem issues progress report.
January through December 1988	Geosystem issues monthly progress reports.
February 24, 1988	DHS transmits DHS and EPA comments on draft RAP.
February 29, 1988	Geosystem issues Draft No. 2, Remedial Action Plan
August 4, 1988	DHS transmits EPA, RWQCB, and DHS comments on Draft No. 2, Remedial Action Plan.
January through March 1989	Geosystem issues monthly progress reports.
February 3, 1989	Geosystem issues the third draft of RAP.
April 24, 1989	Geosystem issues the preliminary final draft of RAP.

NOTES: 1) Definitions:

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
City = City of Ukiah
County = Mendocino County Department of Public Health
Court = Mendocino County Superior Court
CWP = Coast Wood Preserving, Inc.
D'Appolonia = D'Appolonia Consulting Engineers, Inc.
DFG = Department of Fish and Game
Executive Officer = Executive Officer of RWQCB
Geosystem = Geosystem Consultants, Inc.
HEA = H. Esmaili & Associates, Inc.
IT Corporation = International Technology Corporation, formerly D'Appolonia Consulting Engineers, Inc.
RAP = Remedial Action Plan
RWQCB = California Regional Water Quality Control Board, North Coast Region
Superfund = Hazardous Substance Response Trust Fund for CERCLA

APPENDIX B

GROUND WATER MONITORING DATA

Table B.1: Summary of Ground Water Levels

Table B.2: Summary of Ground Water Analyses

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TABLE B.1

SUMMARY OF GROUND WATER LEVELS

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-1	03/23/81	0.58	582.41	
	03/25/81	0.96	582.03	
	04/02/81	1.00	581.99	
	04/04/81		582.08	
	05/08/81	1.39	581.60	
	06/09/81	4.15	578.84	
	09/20/82	1.70	581.29	
	08/29/85	8.85	574.14	
	01/09/87	7.56	575.43	
	01/20/88	0.79	582.20	
CWP-2A	03/23/81	8.70	573.38	
	03/25/81	8.64	573.44	
	04/02/81	8.20	573.88	
	04/04/81		573.98	
	05/08/81	11.92	570.16	
	06/09/81	11.90	570.18	
	09/20/82	8.70	573.38	
	03/01/84	5.12	576.96	
	05/01/85	5.46	576.62	
	10/31/85	10.54	571.54	
	05/01/86	5.25	576.83	
	08/11/86	8.83	573.25	
	01/09/87	9.70	572.38	
	07/21/87	8.15	573.93	
	10/20/87			DRY
	01/20/88	4.86	577.22	
	04/22/88	6.06	576.02	
	07/19/88	8.56	573.52	
	10/24/88	12.06	570.02	

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TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-2B	03/23/81	4.90	577.18	
	03/25/81	4.84	577.24	
	04/02/81	5.00	577.08	
	04/04/81		577.16	
	05/08/81	5.56	576.52	
	06/09/81	6.60	575.48	
	09/20/82	9.10	572.98	
	03/01/84	5.21	576.87	
	05/01/85	5.71	576.37	
	08/29/85	9.45	572.63	
	10/31/85	10.50	571.58	DRY
	05/01/86	5.42	576.66	
	08/11/86	8.54	573.54	
	01/09/87	9.68	572.40	
	04/20/87	5.23	576.85	
	01/20/88	4.90	577.18	
CWP-3	03/23/81	1.20	579.17	
	03/25/81	1.29	579.08	
	04/02/81	4.30	576.07	
	04/04/81		575.15	
	05/08/81	4.53	575.84	
	06/09/81	5.70	574.67	
	09/20/82			DRY
	03/01/84	3.77	576.60	
	05/01/85	5.42	574.95	
	08/01/85			DRY
	10/31/85			DRY
	05/01/86	3.92	576.45	
	01/09/87	6.82	573.55	
	04/20/87	5.41	574.96	
	07/21/87			DRY
	07/23/87			DRY
	10/19/87			DRY
	01/20/88	4.92	575.45	
	04/22/88			DRY
	07/19/88			DRY
	10/24/88			DRY

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-6	12/23/88	9.86	572.16	
CWP-7	09/20/82	10.90	565.85	
	03/01/84	6.50	570.25	
	05/01/85	8.75	568.00	
	08/29/85	12.78	563.97	
	10/31/85	12.88	563.87	
	02/11/86	5.92	570.83	
	02/12/86	5.78	570.97	
	05/01/86	8.25	568.50	
	08/11/86	12.67	564.08	
	01/09/87	11.12	565.63	
	04/20/87	7.75	569.00	
	07/21/87	12.43	564.32	
	10/19/87	13.83	562.92	
	01/20/88	5.23	571.52	
	04/22/88	9.85	566.90	
	07/19/88	12.51	564.24	
	10/24/88	13.89	562.86	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-8	09/20/82	9.80	567.29	
	02/01/84	6.69	570.40	
	03/01/84	6.25	570.84	
	04/02/84	6.42	570.67	
	05/10/84	7.92	569.17	
	05/01/85	7.38	569.71	
	08/29/85	12.55	564.54	
	10/30/85	12.75	564.34	
	10/31/85	12.25	564.84	
	12/03/85	7.92	569.17	
	02/11/86	5.89	571.20	
	02/12/86	5.69	571.40	
	03/26/86	6.21	570.88	
	05/01/86	7.12	569.97	
	06/03/86	9.67	567.42	
	07/01/86	11.00	566.09	
	08/11/86	13.50	563.59	
	09/03/86	10.08	567.01	
	10/06/86	11.85	565.24	
	01/05/87	8.52	568.57	
	01/09/87	10.25	566.84	
	02/25/87	8.30	568.79	
	05/19/87	8.37	568.72	
	06/16/87	10.38	566.71	
	07/21/87	11.87	565.22	
	08/24/87	12.65	564.44	
	09/23/87	12.64	564.45	
	10/19/87	12.52	564.57	
	11/13/87	8.41	568.68	
	12/18/87	7.03	570.06	
	01/20/88	5.38	571.71	
	02/18/88	6.44	570.65	
	03/21/88	7.68	569.41	
	04/22/88	7.71	569.38	
	05/23/88	10.40	566.69	
	06/23/88	11.70	565.39	
	07/19/88	12.50	564.59	
	08/24/88	11.69	565.40	
	09/19/88	11.60	565.49	
	10/24/88	13.28	563.81	
	12/23/88	6.98	570.11	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-11	09/20/82	9.20	570.56	
	02/01/84	7.58	572.18	
	03/01/84	7.33	572.43	
	04/02/84	7.50	572.26	
	05/10/84	8.42	571.34	
	05/01/85	8.42	571.34	
	08/01/85			DRY
	08/29/85	12.00	567.76	
	09/09/85			DRY
	10/01/85			DRY
	10/30/85			DRY
	10/31/85	11.71	568.05	DRY
	12/03/85	10.58	569.18	
	02/11/86	7.55	572.21	
	02/12/86	7.44	572.32	
	05/01/86	8.29	571.47	
	06/03/86	8.67	571.09	
	07/01/86	10.03	569.73	
	08/11/86	12.17	567.59	
	09/03/86	12.24	567.52	
	10/06/86	11.68	568.08	
	01/05/87	10.33	569.43	
	01/09/87	10.60	569.16	
	02/25/87	8.01	571.75	
	04/20/87	8.01	571.75	
	05/19/87	8.87	570.89	
	06/16/87	10.00	569.76	
	07/21/87	11.08	568.68	
	08/24/87	12.02	567.74	
	09/23/87	12.80	566.96	
	10/19/87			DRY
	11/13/87			DRY
	12/18/87	8.46	571.30	
	01/20/88	6.68	573.08	
	02/18/88	7.77	571.99	
	03/21/88	8.33	571.43	
	04/22/88	8.60	571.16	
	05/23/88	9.89	569.87	
	06/23/88	10.40	569.36	
	07/19/88	11.38	568.38	
	08/24/88	12.00	567.76	
	09/19/88	12.57	567.19	
	10/24/88	13.32	566.44	DRY
	11/21/88	11.47	568.29	
	12/23/88	11.21	568.55	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-12	09/20/82	12.50	566.79	
	03/01/84	8.92	570.37	
	05/01/85	11.79	567.50	
	10/31/85	16.38	562.91	
	02/11/86	8.02	571.27	
	02/12/86	7.96	571.33	
	05/01/86	11.25	568.04	
	08/11/86	16.00	563.29	
	01/09/87	15.01	564.28	
	04/20/87	10.77	568.52	
	07/21/87	15.92	563.37	
	10/19/87	16.87	562.42	
	01/20/88	7.01	572.28	
	04/22/88	13.21	566.08	
	07/19/88	15.91	563.38	
	10/24/88	16.97	562.32	

DRAFT

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-13	09/20/82	10.30	568.89	
	03/01/84	8.71	570.48	
	05/01/85	10.42	568.77	
	08/29/85	14.60	564.59	
	10/30/85	14.96	564.23	
	10/31/85	14.44	564.75	
	12/03/85	14.02	565.17	
	02/11/86	8.01	571.18	
	02/12/86	7.79	571.40	
	03/26/86	8.40	570.79	
	05/01/86	9.96	569.23	
	06/03/86	12.21	566.98	
	07/01/86	13.00	566.19	
	08/11/86	14.25	564.94	
	09/03/86	14.71	564.48	
	10/06/86	14.41	564.78	
	01/05/87	11.58	567.61	
	01/09/87	13.06	566.13	
	02/25/87	9.87	569.32	
	04/20/87	9.70	569.49	
	05/19/87	10.66	568.53	
	06/16/87	12.42	566.77	
	07/21/87	14.05	565.14	
	08/24/87	14.14	565.05	
	09/23/87	15.19	564.00	
	10/19/87	15.00	564.19	
	11/13/87	11.88	567.31	
	12/18/87	10.50	568.69	
	01/20/88	8.36	570.83	
	02/18/88	9.24	569.95	
	03/21/88	11.44	567.75	
	04/22/88	11.59	567.60	
	05/23/88	14.24	564.95	
	06/23/88	13.81	565.38	
	07/19/88	14.45	564.74	
	08/24/88	14.18	565.01	
	09/19/88	14.25	564.94	
	10/24/88	15.93	563.26	
	11/21/88	14.51	564.68	
	12/23/88	10.19	569.00	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-14	09/20/82	11.50	566.15	
	03/01/84	7.42	570.23	
	05/01/85	9.40	568.25	
	08/29/85	13.25	564.40	
	10/31/85	13.29	564.36	
	02/11/86	6.53	571.12	
	02/12/86	6.37	571.28	
	05/01/86	8.98	568.67	
	08/11/86	13.00	564.65	
	01/09/87	11.53	566.12	
	04/20/87	8.19	569.46	
	07/21/87	12.72	564.93	
	10/19/87	14.04	563.61	
	01/20/88	6.02	571.63	
	04/22/88	4.90	572.75	
	07/19/88	12.91	564.74	
	10/24/88	14.31	563.34	
CWP-15	09/20/82	7.40	572.56	
	08/29/85	10.80	569.16	
	02/11/86	6.15	573.81	
	02/12/86	5.95	574.01	
	01/09/87	8.48	571.48	
	01/20/88	5.74	574.22	
CWP-16	09/20/82	10.00	571.84	
	08/29/85	11.70	570.14	
	01/09/87	9.32	572.52	
	01/20/88	6.39	575.45	

DRAFT

GEOSYSTEM

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-17	05/01/85	13.25	567.94	
	10/30/85	17.50	563.69	
	10/31/85	16.96	564.23	
	12/03/85	15.73	565.46	
	02/12/86	11.31	569.88	
	03/26/86	10.62	570.57	
	05/01/86	12.19	569.00	
	06/03/86	14.42	566.77	
	07/01/86	15.41	565.78	
	08/11/86	17.00	564.19	
	09/03/86	16.82	564.37	
	10/06/86	16.83	564.36	
	01/05/87	17.10	564.09	
	01/09/87	16.06	565.13	
	02/25/87	13.36	567.83	
	04/20/87	10.67	570.52	
	05/19/87	14.26	566.93	
	07/21/87	16.26	564.93	
	10/19/87	17.87	563.32	
	01/20/88	10.79	570.40	
	04/22/88	13.37	567.82	
	07/19/88	16.84	564.35	
	10/24/88	17.85	563.34	
CWP-18	02/12/86	6.34	576.35	
	01/09/87	12.31	570.38	
	04/20/87	6.64	576.05	
	07/21/87	12.50	570.19	
	10/19/87	12.93	569.76	
	01/20/88	6.21	576.48	
	04/22/88	7.40	575.29	
	07/19/88	9.56	573.13	
	10/24/88			DRY
CWP-19	01/09/87	9.35	574.02	TRENCH

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-20	02/11/86	4.72	573.80	
	02/12/86	4.51	574.01	
	03/26/86	5.12	573.40	
	01/05/87	7.80	570.72	
	01/09/87	7.59	570.93	
	02/25/87	5.92	572.60	
	04/20/87	6.05	572.47	
	05/19/87	6.37	572.15	
	06/16/87	8.06	570.46	
	07/21/87	7.79	570.73	
	08/24/87	9.85	568.67	
	09/23/87	11.81	566.71	
	10/19/87	11.17	567.35	
	11/13/87	9.67	568.85	
	12/18/87	2.45	576.07	
	01/20/88	4.98	573.54	
	02/18/88	5.57	572.95	
	03/21/88	6.00	572.52	
	04/22/88	6.18	572.34	
	05/23/88	7.27	571.25	
	06/23/88	7.57	570.95	
	07/19/88	8.68	569.84	
	08/24/88	9.91	568.61	
	09/19/88	10.46	568.06	
	10/24/88	11.44	567.08	
	11/21/88	9.99	568.53	
	12/23/88	7.85	570.67	

DRAFT

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-21	01/12/86	3.05	576.34	
	02/11/86	3.41	575.98	
	03/26/86	8.03	571.36	
	01/05/87	13.51	565.88	
	01/09/87	13.50	565.89	
	02/25/87	9.03	570.36	
	04/20/87	9.14	570.25	
	05/19/87	10.28	569.11	
	06/16/87	11.47	567.92	
	07/21/87	13.09	566.30	
	08/24/87	7.86	571.53	
	09/23/87	14.67	564.72	
	10/19/87	14.59	564.80	
	11/13/87	13.80	565.59	
	12/18/87	8.80	570.59	
	01/20/88	6.34	573.05	
	02/18/88	9.15	570.24	
	03/21/88	9.57	569.82	
	04/22/88	11.42	567.97	
	05/23/88	12.68	566.71	
	06/23/88	12.82	566.57	
	07/19/88	13.41	565.98	
	08/24/88	13.85	565.54	
	09/19/88	14.11	565.28	
	10/24/88	15.00	564.39	
	11/21/88	14.25	565.14	
	12/23/88	13.07	566.32	
CWP-22	03/26/86	7.93	572.09	
	01/09/87	11.08	568.94	
	02/25/87	8.72	571.30	
	04/20/87	8.61	571.41	
	05/19/87	9.70	570.32	

D R A F T

GEOSYSTEM

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
HL-7	02/11/86	5.57	572.79	
	02/12/86	5.62	572.74	MAY NOT HAVE FULLY RECOVERED FROM STEP DRA
	01/05/87	12.50	565.86	
	01/09/87	13.53	564.83	
	02/25/87	7.63	570.73	
	04/20/87	7.73	570.63	
	05/19/87	9.08	569.28	
	06/16/87	10.30	568.06	
	07/21/87	12.82	565.54	
	08/24/87	14.16	564.20	
	09/23/87	13.41	564.95	
	10/19/87	13.11	565.25	
	11/13/87	12.71	565.65	
	12/18/87	8.46	569.90	
	01/20/88	4.98	573.38	
	02/18/88	7.52	570.84	
	03/21/88	8.08	570.28	
	04/22/88	10.59	567.77	
	05/23/88	11.48	566.88	
	06/23/88	11.79	566.57	
	07/19/88	12.31	566.05	
	08/24/88	12.71	565.65	
	09/19/88	12.71	565.65	
	10/24/88	13.76	564.60	
	12/23/88	11.44	566.92	
FPT-1A	09/20/82	8.00	-8.00	
	08/29/85	7.69	-7.69	
FPT-1B	09/20/82	7.60	567.63	
	08/29/85	7.53	567.70	
	01/09/87	6.27	568.96	
FPT-2A	04/20/87	1.24	567.44	
	01/20/88	1.83	566.85	
FPT-2B	09/20/82	4.10	564.58	
	03/01/84	0.25	568.43	
	05/01/85	1.79	566.89	
	08/29/85	7.70	560.98	
	10/31/85	5.25	563.43	
	05/01/86	1.42	567.26	
	08/11/86	7.25	561.43	
	01/09/87	2.70	565.98	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
FPT-2C	08/29/85	7.72	561.09	
	01/09/87	3.00	565.81	
FPT-3	09/20/82	9.80	565.77	
	02/01/84	6.21	569.36	
	03/01/84	5.50	570.07	
	04/02/84	5.96	569.61	
	05/10/84	8.17	567.40	
	05/01/85	7.83	567.74	
	08/29/85	12.10	563.47	
	10/30/85	12.50	563.07	
	10/31/85	12.16	563.41	
	12/03/85	8.06	567.51	
	03/26/86	5.31	570.26	
	05/01/86	7.25	568.32	
	06/03/86	9.54	566.03	
	07/01/86	10.31	565.26	
	08/11/86	11.92	563.65	
	09/03/86	12.56	563.01	
	10/06/86	12.21	563.36	
	01/05/87	9.16	566.41	
	01/09/87	10.10	565.47	
	02/25/87	6.38	569.19	
	04/20/87	6.76	568.81	
	05/19/87	7.67	567.90	
	06/16/87	9.60	565.97	
	07/21/87	11.38	564.19	
	08/24/87	12.47	563.10	
	09/23/87	13.03	562.54	
	10/19/87	12.98	562.59	
	11/13/87	9.47	566.10	
	12/18/87	6.35	569.22	
	01/20/88	3.00	572.57	
	02/18/88	6.00	569.57	
	03/21/88	7.72	567.85	
	04/22/88	8.86	566.71	
	05/23/88	10.73	564.84	
	06/23/88	11.11	564.46	
	07/19/88	11.87	563.70	
	08/24/88	11.93	563.64	
	09/19/88	12.47	563.10	
	10/24/88	13.22	562.35	
	11/21/88	11.42	564.15	
	12/23/88	9.51	566.06	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
FPT-4	03/01/84	4.17	569.13	
	05/01/85	5.50	567.80	
	08/29/85	9.49	563.81	
	10/31/85	9.75	563.55	
	05/01/86	5.25	568.05	
	08/11/86	9.33	563.97	
	01/09/87	6.83	566.47	
	04/20/87	4.48	568.82	
	07/21/87	9.08	564.22	
	10/19/87	10.69	562.61	
	01/20/88	1.90	571.40	
	04/22/88	6.25	567.05	
	07/19/88	9.30	564.00	
	10/24/88	10.63	562.67	

D R A F T

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
FPT-5	02/01/84	3.29	568.61	
	03/01/84	2.94	568.96	
	04/02/84	3.25	568.65	
	05/10/84	4.67	567.23	
	05/01/85	4.71	567.19	
	08/29/85	8.05	563.85	
	10/30/85	7.96	563.94	
	10/31/85	8.29	563.61	
	12/03/85	3.81	568.09	
	03/26/86	2.23	569.67	
	05/01/86	4.29	567.61	
	06/03/86	5.96	565.94	
	07/01/86	6.62	565.28	
	08/11/86	8.38	563.52	
	09/03/86	8.79	563.11	
	10/06/86	8.64	563.26	
	01/05/87	5.44	566.46	
	01/09/87	5.48	566.42	
	02/25/87	2.90	569.00	
	04/20/87	3.24	568.66	
	05/19/87	3.90	568.00	
	06/16/87	5.79	566.11	
	07/21/87	7.50	564.40	
	08/24/87	8.54	563.36	
	09/23/87	9.10	562.80	
	10/19/87	9.32	562.58	
	11/13/87	6.23	565.67	
	12/18/87	2.78	569.12	
	01/20/88	0.59	571.31	
	02/18/88	2.49	569.41	
	03/21/88	4.00	567.90	
	04/22/88	4.95	566.95	
	05/23/88	6.75	565.15	
	06/23/88	7.00	564.90	
	07/19/88	7.25	564.65	
	08/24/88	8.02	563.88	
	09/19/88	8.41	563.49	
	10/24/88	9.24	562.66	
	11/21/88	7.07	564.83	
	12/23/88	3.22	568.68	

DRAFT

GEOSYSTEM

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
AT-1	02/01/84	1.25	571.70	
	03/01/84	0.27	572.68	
	04/02/84	1.25	571.70	
	05/10/84	3.33	569.62	
	05/01/85	3.17	569.78	
	10/30/85	7.67	565.28	
	10/31/85	7.46	565.49	
	12/03/85	3.06	569.89	
	03/26/86	3.51	569.44	
	05/01/86	2.71	570.24	
	06/03/86	4.96	567.99	
	07/01/86	5.71	567.24	
	08/11/86	6.25	566.70	
	09/03/86	7.83	565.12	
	10/06/86	7.72	565.23	
	01/05/87	5.60	567.35	
	01/09/87	9.57	563.38	
	02/25/87	5.06	567.89	
	04/20/87	5.88	567.07	
	05/19/87	5.84	567.11	
	06/16/87	8.17	564.78	
	07/21/87	10.00	562.95	
	08/24/87	11.48	561.47	
	09/23/87	11.68	561.27	
	10/19/87	11.82	561.13	
	11/13/87	10.46	562.49	
	12/18/87	4.92	568.03	
	01/20/88	2.66	570.29	
	02/18/88	4.72	568.23	
	03/21/88	6.64	566.31	
	04/22/88	8.21	564.74	
	05/23/88	9.70	563.25	
	06/23/88	9.80	563.15	
	07/19/88	10.73	562.22	
	08/24/88	10.25	562.70	
	09/19/88	11.25	561.70	
	10/24/88	11.78	561.17	
	11/21/88	10.82	562.13	
	12/23/88	8.24	564.71	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
AT-2	02/01/84	-0.50	571.60	WATER LEVEL 6 INCHES ABOVE WELL CASING
	03/01/84			ARTESIAN CONDITIONS.
	04/02/84	-0.50	571.60	
	05/10/84	1.33	569.77	
	05/01/85	1.08	570.02	
	10/30/85	5.79	565.31	
	10/31/85	5.75	565.35	
	03/26/86	2.07	569.03	
	05/01/86	1.42	569.68	
	06/03/86	2.92	568.18	
	07/01/86	3.79	567.31	
	08/11/86	4.83	566.27	
	09/03/86	6.02	565.08	
	10/06/86	6.04	565.06	
	01/05/87	4.00	567.10	
	01/09/87	7.82	563.28	
	02/25/87	3.46	567.64	
	04/20/87	12.63	558.47	
	05/19/87	3.98	567.12	
	06/16/87	6.40	564.70	
	07/21/87	8.57	562.53	
	08/24/87	9.81	561.29	
	09/23/87	10.16	560.94	
	10/19/87	10.35	560.75	
	11/13/87	9.00	562.10	
	12/18/87	3.24	567.86	
	01/20/88	1.41	569.69	
	02/18/88	3.15	567.95	
	03/21/88	4.93	566.17	
	04/22/88	6.55	564.55	
	05/23/88	7.91	563.19	
	06/23/88	8.01	563.09	
	07/19/88	8.94	562.16	
	08/24/88	8.52	562.58	
	09/19/88	9.46	561.64	
	10/24/88	10.26	560.84	
	11/21/88	9.11	561.99	
	12/23/88	6.51	564.59	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-9	09/20/82	8.50	570.71	
	08/29/85	10.05	569.16	
	02/11/86	5.47	573.74	
	02/12/86	5.27	573.94	
	01/09/87	8.76	570.45	
	01/20/88	5.03	574.18	
CWP-10	09/20/82	11.30	571.09	
	03/01/84	9.12	573.27	
	03/26/86	7.18	575.21	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-4A	03/23/81	10.80	568.03	
	03/25/81	12.21	566.62	
	04/02/81	10.80	568.03	
	04/04/81		567.98	
	06/09/81	10.50	568.33	
	09/20/82	5.10	573.73	
	01/09/87	10.44	568.39	
	01/20/88			DRY
CWP-4D	03/23/81	2.83	575.93	
	03/25/81	2.50	576.26	
	04/02/81	2.45	576.31	
	04/04/81		576.45	
	05/08/81	3.24	575.52	
	06/09/81	4.20	574.56	
	09/20/82	7.90	570.86	
	01/09/87	6.11	572.65	
	01/20/88	1.91	576.85	
CWP-5	03/23/81	8.49	569.61	
	03/25/81	8.51	569.59	
	04/02/81	8.50	569.60	
	04/04/81		570.88	
	05/08/81	9.21	568.89	
	06/09/81	10.50	567.60	
	09/20/82			DRY
	03/01/84	8.08	570.02	
	01/30/85			DRY
	05/03/85			DRY
	08/01/85			DRY
	10/31/85			DRY
	01/12/86	2.24	575.86	
	05/01/86			DRY
	01/09/87	9.88	568.22	
	04/20/87	7.65	570.45	
	07/21/87			DRY
	07/23/87			DRY
	10/19/87			DRY
	01/20/88	4.89	573.21	
	04/22/88			DRY
	07/19/88			DRY
	10/24/88			DRY

DRAFT

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
CWP-6	03/23/81	6.05	575.97	
	03/25/81	5.45	576.57	
	04/02/81	5.15	576.87	
	04/04/81		577.09	
	05/08/81	6.08	575.94	
	06/09/81	7.20	574.82	
	09/20/82	9.10	572.92	
	02/01/84	5.98	576.04	
	04/02/84	6.00	576.02	
	05/10/84	6.79	575.23	
	05/01/85	6.46	575.56	
	08/29/85	10.05	571.97	
	10/01/85			DRY
	10/30/85			DRY
	10/31/85	10.96	571.06	
	12/03/85	9.42	572.60	
	02/13/86	5.80	576.22	
	03/26/86	6.67	575.35	
	05/01/86	6.21	575.81	
	06/03/86	6.92	575.10	
	07/01/86	7.56	574.46	
	08/11/86	8.88	573.14	
	09/03/86	10.79	571.23	
	10/06/86	10.98	571.04	
	01/05/87	9.72	572.30	
	01/09/87	10.48	571.54	
	02/25/87	6.70	575.32	
	04/20/87	6.97	575.05	
	05/19/87	6.81	575.21	
	07/21/87	8.65	573.37	
	08/24/87	10.70	571.32	
	09/23/87			DRY
	10/20/87			DRY
	11/13/87			DRY
	12/18/87	7.25	574.77	
	01/20/88	5.60	576.42	
	02/18/88	6.56	575.46	
	03/21/88	6.69	575.33	
	04/22/88	6.81	575.21	
	05/23/88	7.54	574.48	
	06/23/88	6.98	575.04	
	07/19/88	8.64	573.38	
	08/24/88	10.12	571.90	
	09/19/88	10.77	571.25	
	10/24/88	12.70	569.32	DRY
	11/21/88	10.72	571.30	DRY

D R A F T

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
AT-3	02/01/84	-2.00	572.04	WATER LEVEL ABOUT 2 FEET ABOVE WELL CASING
	03/01/84			ARTESIAN CONDITIONS.
	04/02/84	-1.25	571.29	
	05/10/84	0.08	569.96	
	05/01/85	0.33	569.71	
	10/30/85	4.50	565.54	
	10/31/85	4.35	565.69	
	12/03/85			WATER STANDING OVER WELL.
	03/26/86	1.68	568.36	
	05/01/86			WATER STANDING OVER WELL.
	06/03/86	1.58	568.46	
	07/01/86	2.39	567.65	
	08/11/86	3.25	566.79	
	09/03/86	4.50	565.54	
	10/06/86	4.40	565.64	
	01/05/87	1.95	568.09	
	01/09/87	5.72	564.32	
	02/25/87	2.40	567.64	
	04/20/87	18.83	551.21	
	05/19/87	2.43	567.61	
	06/16/87	4.48	565.56	
	07/21/87	6.15	563.89	
	08/24/87	8.32	561.72	
	09/23/87	8.71	561.33	
	10/19/87	8.85	561.19	
	11/13/87	7.04	563.00	
	12/18/87	2.09	567.95	
	01/20/88	1.43	568.61	
	02/18/88	2.27	567.77	
	03/21/88	3.48	566.56	
	04/22/88	4.69	565.35	
	05/23/88	6.01	564.03	
	06/23/88	6.59	563.45	
	07/19/88	7.36	562.68	
	08/24/88	6.73	563.31	
	09/19/88	7.68	562.36	
	10/24/88	8.83	561.21	
	11/21/88	7.49	562.55	
	12/23/88	3.94	566.10	

TABLE B.1
(continued)

WELL	DATE	DEPTH TO WATER (ft)	WATER SURFACE ELEVATION (ft above MSL)	COMMENTS
AT-4	03/26/86	4.64	566.69	
	01/09/87	9.43	561.90	
	02/25/87	5.74	565.59	
	04/20/87	20.94	550.39	
	05/19/87	6.30	565.03	
	07/21/87	10.00	561.33	
	10/19/87	12.03	559.30	
	01/20/88	2.56	568.77	
	04/22/88	8.35	562.98	
	07/19/88	10.68	560.65	
	10/24/88	12.20	559.13	
AT-5	03/26/86	1.26	568.07	
	01/09/87	7.45	561.88	
	02/25/87	2.53	566.80	
	04/20/87	9.90	559.43	
	05/19/87	1.59	567.74	
	06/16/87	4.10	565.23	
	07/21/87	7.86	561.47	
	08/24/87	9.28	560.05	
	09/23/87	9.29	560.04	
	10/19/87	8.78	560.55	
	11/13/87	9.03	560.30	
	12/18/87	2.36	566.97	
	01/20/88	1.08	568.25	
	02/18/88	3.01	566.32	
	03/21/88	4.36	564.97	
	04/22/88	6.52	562.81	
	05/23/88	7.01	562.32	
	06/23/88	6.37	562.96	
	07/19/88	8.22	561.11	
	08/24/88	6.33	563.00	
	09/19/88	7.84	561.49	
	10/24/88	9.32	560.01	
	11/21/88	4.70	564.63	
	12/23/88	6.91	562.42	

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	DISSOLVED CHROMIUM TOTAL	ARSENIC	COPPER	COMMENTS
CWP-4D	04/02/81		<0.01		<0.01	
	06/09/81		0.004	0.001	0.034	
	09/28/82	<0.02	<0.02	<0.004	<0.02	
	03/20/84		<0.01		<0.05	
	01/18/88		<0.02			
CWP-5	04/02/81		43		0.02	
	06/09/81		31	0.002	<0.01	
	06/16/83		24		0.03	
	12/08/83	19	19		<0.02	
	03/01/84	15	15		0.02	
	03/21/84		14		<0.05	
	01/30/85					DRY
	05/03/85					DRY
	08/01/85					DRY
	10/31/85					DRY
	02/19/86		14			
	05/01/86					DRY
	04/20/87		12			
	07/23/87					DRY
	10/19/87					DRY
	01/20/88		12			
	04/22/88					DRY
	07/19/88					DRY
	10/24/88					DRY

TABLE B.2

SUMMARY OF GROUND WATER ANALYSES
(All units are mg/l)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-1	04/02/81		<0.01		<0.01	
	05/08/81		<0.01		<0.01	
	06/09/81		0.001	0.004	0.024	
	09/28/82	<0.02	<0.02	<0.004	<0.02	
	03/20/84		<0.01		<0.05	
	01/18/88		<0.02			
CWP-2A	08/31/00	0.39				
	04/02/81		2.2		<0.01	
	06/09/81		0.01	0.003	<0.01	
	09/28/82	5.18	5.9	0.092	0.05	
	06/16/83		2.3	0.3	0.12	
	10/04/83	0.39	3.6	1.8	1.8	
	12/08/83	2.4	2.4	0.26	<0.02	
	03/01/84	11	11	0.36	0.03	
	03/25/84		0.56	0.058	<0.05	
	01/30/85		0.24			
	05/03/85		1.9			
	08/01/85		0.04			
	10/31/85		6.6			
	02/19/86		6.5			
	05/01/86		2.8			
	08/13/86		0.31			
	04/20/87		1.4			
	07/22/87		0.38			
	10/20/87					DRY
	01/20/88		0.94			
	04/25/88		0.40			
	07/20/88		0.59			
	10/25/88		1.3			

DRAFT

GEOSYSTEM

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-2B	08/31/00	4.0				
	04/02/81		14		<0.01	
	06/09/81		16	0.001	<0.01	
	09/28/82	12	13		<0.02	
	06/16/83		3.7	0.041	0.08	
	10/04/83	4.0	9.2	0.32	3.2	
	12/08/83	8.5	9.0		<0.02	
	03/01/84	11	11	0.015	<0.02	
	03/21/84		2.4		<0.05	
	03/21/84	2.4	2.5	0.01	<0.01	
	01/30/85		1.4			
	05/03/85		1.0			
	08/01/85		0.79			
	10/31/85					DRY
	02/19/86		6.0			
	05/01/86		1.7			
	08/13/86		6.3			
	04/20/87		3.8			
	01/19/88		2.7			
CWP-3	04/02/81		0.02		0.02	
	06/09/81		0.004	0.001	0.033	
	06/16/83		0.05	0.021	0.06	
	12/08/83	0.07	0.09		<0.02	
	03/01/84	<0.02	0.16	0.65	0.003	
	03/21/84		<0.01	0.028	<0.05	
	01/30/85		0.04			
	05/03/85		0.18			
	08/01/85					DRY
	10/31/85					DRY
	02/19/86		0.04			
	05/01/86		<0.02			
	04/20/87		0.07			
	07/23/87					DRY
	10/19/87					DRY
	01/18/88		<0.02			
	04/22/88					DRY
	07/19/88					DRY
	10/24/88					DRY
CWP-4A	04/02/81		0.04		0.02	
	09/28/82	<0.02	<0.02	<0.004	<0.02	
	03/25/84		0.057	0.06	<0.05	
	01/20/88					DRY

DRAFT

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-6	04/02/81		125		0.02	
	05/08/81		120	0.006	<0.01	
	06/09/81		120	0.002	<0.01	
	06/16/83		75		0.03	
	08/13/83	78	78	0.003	<0.05	
	12/08/83	72	75	0.08	<0.02	
	01/06/84	23	22		<0.02	
	01/24/84	64	72		<0.02	
	02/01/84	36	73		<0.02	
	03/01/84	70	70		<0.02	
	03/21/84		50		<0.05	
	03/21/84	63	70	0.01	<0.01	
	04/02/84	62	63		<0.02	
	12/04/84	59	59		<0.02	
	01/03/85	59	59		<0.02	
	01/30/85		65			
	03/01/85		40			
	04/01/85		57			
	05/03/85		29			
	07/02/85		42			
	08/01/85		48			
	09/09/85		50			
	10/01/85					DRY
	10/31/85		12			
	12/04/85		12			
	01/02/86		34			
	02/1[illegible]/86		13			
	03/1[illegible]/86		14			
	04/03/86		26			
	05/01/86		48			
	08/13/86		35			
	09/03/86		<0.02			
	10/06/86		17			
	02/25/87		37			
	03/27/87		54			
	04/20/87		51			
	05/19/87		60			
	05/20/87		60			
	06/16/87		62			
	07/22/87		50			
	08/24/87		41			
	10/20/87					DRY
	11/13/87					DRY
	12/21/87		40			
	01/20/88		50			
	02/18/88		67			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	DISSOLVED CHROMIUM TOTAL	ARSENIC	COPPER	COMMENTS
CWP-6	03/21/88		81			
	04/22/88		59			
	05/23/88		67			
	06/24/88		40			
	07/19/88		73			
	08/24/88		56			
	09/19/88		42			
	10/24/88					DRY
	11/21/88					DRY
	12/23/88		6.9			
CWP-7	09/20/82	<0.02	<0.02	<0.004	<0.02	
	12/08/83	<0.01	<0.05	<0.05	<0.02	
	03/01/84	<0.02	0.20	<0.004	<0.02	
	03/20/84		<0.01		<0.05	
	03/21/84	<0.005	<0.005	<0.005	<0.001	
	01/30/85		<0.02			
	05/03/85		<0.02			
	08/01/85		<0.02			
	10/31/85		<0.02			
	02/13/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	04/20/87		<0.02			
	07/21/87		<0.02			
	10/19/87		<0.02			
	01/18/88		<0.02			
	04/25/88		<0.02			
	10/24/88		<0.02			

DRAFT

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-8	08/31/00	7.8				
	09/20/82	13	14		<0.02	
	06/16/83		22		<0.02	
	07/19/83	12	12		<0.02	
	07/20/83	11	11		<0.02	
	07/21/83	11	11		<0.02	
	07/22/83	11	11		<0.02	
	07/23/83	10	10		<0.02	
	07/28/83	8.75	9.6		<0.02	
	07/28/83	8.48	9.2		<0.02	
	08/02/83	6.9	7.3		<0.05	
	08/04/83	6.8	6.9		<0.05	
	08/09/83	6.6	6.9		<0.05	
	08/11/83	<0.05	<0.05	0.002	<0.05	
	08/12/83	6.6	6.8		<0.05	
	08/13/83	6.6	6.9	0.002	<0.05	
	10/04/83	7.8	8.8	0.005	<0.05	
	12/08/83	0.74	1.1		<0.02	
	12/12/83		0.53			
	12/13/83		0.94			
	01/06/84	1.0	1.0		<0.02	
	01/24/84	0.9	0.90		<0.02	
	01/24/84	1.3	1.4		<0.02	
	02/01/84	0.9	0.90		0.02	
	03/01/84	1.2	1.2		<0.02	
	03/20/84		1.1		<0.05	
	03/21/84	1.2	1.3		<0.001	
	04/02/84	1.3	1.4		<0.02	
	12/04/84	0.47	0.47		<0.02	
	01/03/85	0.52	0.52		<0.02	
	01/30/85		0.29			
	01/31/85	0.52	0.52		<0.02	
	03/01/85		0.40			
	04/01/85		0.11			
	05/03/85		0.10			
	07/02/85		0.15			
	08/01/85		0.05			
	09/09/85		<0.02			
	10/01/85		<0.02			
	10/31/85		<0.02			
	12/04/85		<0.02			
	01/02/86		<0.02			
	02/19/86		0.10			
	03/14/86		0.06			
	04/03/86		0.05			
	05/01/86		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-8	08/13/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	12/03/86		<0.02			
	01/05/87		0.09			
	02/25/87		0.05			
	03/27/87		0.09			
	03/27/87		0.09			
	04/20/87		0.03			
	04/20/87		0.03			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/21/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/19/87		<0.02			
	11/13/87		0.15			
	12/18/87		0.04			
	01/18/88		0.14			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/22/88		0.02			
	05/23/88		<0.02			
	06/23/88		<0.02			
	07/19/88		<0.02			
	08/23/88		<0.02			
	09/19/88		<0.02			
	10/24/88		<0.02			
	11/21/88		<0.02			
	12/23/88		0.19			
CWP-9	09/20/82	<0.02	<0.02	<0.004	<0.02	
	03/20/84		<0.01	0.053	<0.05	
	03/21/84	<0.005	<0.005	<0.005	<0.001	
	01/20/88		<0.02			
CWP-10	08/31/00	0.077	0.169	0.043		
	08/31/00	0.26	0.60	0.053		
	09/20/82	<0.02	<0.02	<0.004	<0.02	
	06/16/83		0.07		0.02	
	12/08/83	5.7	5.8		<0.02	
	01/24/84	0.17	0.17	0.015	<0.02	
	03/01/84	18	18	0.042	0.20	
	03/21/84	41	50	1.8	1.1	
	03/21/84		37	2.1	1.0	

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TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-11	08/31/00	0.07				
	09/28/82	<0.02	0.05	<0.004	<0.02	
	06/16/83		0.04		<0.02	
	08/13/83	0.05	0.05	0.018	<0.05	
	10/04/83	0.07	1.9	0.95	16.0	
	12/08/83	0.04	0.05		<0.02	
	01/06/84	0.03	0.05		<0.02	
	01/24/84	0.03	0.03		<0.02	
	02/01/84	0.04	<0.05		<0.02	
	03/01/84	0.03	0.03		<0.02	
	03/21/84		0.016		<0.05	
	04/02/84	0.04	0.04		<0.02	
	06/16/84		0.04		<0.02	
	12/04/84	<0.02	<0.02	0.01	<0.02	
	01/03/85	0.02	0.02		<0.02	
	01/30/85		<0.02			
	03/01/85		<0.02			
	04/01/85		0.02			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85					DRY
	09/09/85					DRY
	10/01/85					DRY
	10/31/85					DRY
	12/04/85		<0.02			
	01/02/86		<0.02			
	02/13/86		<0.02			
	03/14/86		<0.02			
	04/03/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	01/05/87		<0.02			
	02/25/87		<0.02			
	03/27/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/21/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/19/87					DRY
	11/13/87					DRY
	12/18/87		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-11	01/18/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/22/88		<0.02			
	05/23/88		<0.02			
	06/23/88		<0.02			
	07/19/88		<0.02			
	08/23/88		<0.02			
	09/19/88		<0.02			
	10/24/88					DRY
	11/21/88		<0.02			
	12/23/88		<0.02			
CWP-12	08/31/00	0.05				
	09/20/82	<0.02	<0.02	<0.004	<0.02	
	09/28/82	<0.02	<0.02	<0.004	<0.02	
	06/16/83		<0.02	0.027	0.03	
	10/04/83	<0.05	0.047	0.063	0.51	
	12/08/83	<0.01	<0.05	<0.05	<0.02	
	03/01/84	<0.02	<0.02	<0.004	<0.02	
	03/20/84		<0.01	0.032	<0.05	
	01/30/85		<0.02			
	08/01/85		<0.02			
	10/31/85		<0.02			
	02/13/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	04/20/87		<0.02			
	07/21/87		<0.02			
	10/19/87		<0.02			
	01/18/88		<0.02			
	04/22/88		<0.02			
	07/19/88		<0.02			
	10/24/88		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-13	09/20/82	<0.02	0.02	<0.004	<0.02	
	06/16/83		<0.02		<0.02	
	12/08/83	<0.01	<0.05	<0.05	<0.02	
	01/24/84	<0.01	<0.01	<0.005	<0.02	
	03/01/84	<0.02	<0.02	<0.004	0.03	
	03/21/84		0.081		<0.05	
	01/30/85		<0.02			
	03/01/85		<0.02			
	04/01/85		<0.02			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85		<0.02			
	09/09/85		<0.02			
	10/01/85					DRY
	10/01/85		<0.02			
	10/31/85		<0.02			
	12/04/85		<0.02			
	01/02/86		<0.02			
	02/13/86		<0.02			
	03/14/86		<0.02			
	04/03/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	12/03/86		<0.02			
	01/05/87		<0.02			
	02/25/87		<0.02			
	03/27/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/21/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/19/87		<0.02			
	11/13/87		<0.02			
	12/18/87		<0.02			
	01/18/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/22/88		<0.02			
	05/23/88		<0.02			
	06/23/88		<0.02			
	07/19/88		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-13	08/23/88		<0.02			
	09/19/88		<0.02			
	10/24/88		<0.02			
	11/21/88		<0.02			
	12/23/88		<0.02			
CWP-14	08/31/00	0.05				
	08/31/00	0.05				
	09/20/82	<0.02	<0.02	<0.004	<0.02	
	06/16/83		<0.02		<0.02	
	10/04/83	<0.05	0.05	0.064	1.2	
	12/08/83	<0.01	<0.05	<0.05	<0.02	
	03/01/84	<0.02	<0.02	<0.004	<0.02	
	03/21/84		<0.01		<0.05	
	01/30/85		<0.02			
	05/03/85		<0.02			
	08/01/85		<0.02			
	10/31/85		<0.02			
	02/13/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	04/20/87		<0.02			
	07/21/87		<0.02			
	10/19/87		<0.02			
	01/18/88		<0.02			
	04/2[illegible]/88		<0.02			
	07/19/88		<0.02			
	10/24/88		<0.02			
CWP-15	09/20/82	<0.02	<0.02	<0.004	<0.02	
	03/21/84		<0.01		<0.05	
	01/18/88		<0.02			
CWP-16	09/28/82	<0.02	<0.02	<0.004	<0.02	
	03/21/84		<0.01		<0.05	
	01/18/88		<0.02			

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TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	DISSOLVED CHROMIUM TOTAL	ARSENIC	COPPER	COMMENTS
CWP-17	01/31/85	<0.01	<0.01	<0.01	0.078	
	03/01/85		<0.02			
	04/01/85		<0.02			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85		<0.02			
	09/09/85		<0.02			
	10/01/85		<0.02			
	10/31/85		<0.02			
	12/04/85		<0.02			
	01/02/86		<0.02			
	02/13/86		<0.02			
	03/14/86		<0.02			
	04/03/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	12/03/86		<0.02			
	01/05/87		<0.02			
	02/25/87		<0.02			
	03/27/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	07/21/87		<0.02			
	10/19/87		<0.02			
	01/18/88		<0.02			
	04/25/88		<0.02			
	07/19/88		<0.02			
	10/24/88		<0.02			
CWP-18	04/20/87		12			
	07/22/87		23			
	10/20/87		22			
	01/18/88		37			
	04/25/88		31			
	07/19/88		18			
	10/24/88					DRY

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	DISSOLVED CHROMIUM TOTAL	ARSENIC	COPPER	COMMENTS
CWP-20	12/03/86		<0.02			
	01/05/87		<0.02			
	02/25/87		<0.02			
	03/26/87		0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/21/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/19/87		<0.02			
	11/13/87		<0.02			
	12/21/87		<0.02			
	01/18/88		<0.02			
	02/18/88		0.09			
	03/21/88		<0.02			
	04/25/88		0.05			
	05/23/88		0.06			
	06/23/88		0.02			
	07/19/88		<0.02			
	08/23/88		<0.02			
	09/19/88		<0.02			
	10/24/88		<0.02			
	11/21/88		<0.02			
	12/23/88		<0.02			

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TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
CWP-21	12/03/86		<0.02			
	01/05/87		0.02			
	02/25/87		<0.02			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/21/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/19/87		<0.02			
	11/13/87		<0.02			
	12/21/87		<0.02			
	01/18/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/22/88		<0.02			
	05/23/88		<0.02			
	06/23/88		<0.02			
	07/19/88		<0.02			
	08/23/88		<0.02			
	09/19/88		<0.02			
	10/24/88		<0.02			
	11/21/88		<0.02			
	12/26/88		<0.02			
CWP-22	01/06/87		<0.02			
	02/25/87		<0.02			
	03/27/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
HL-7	12/03/86		5.8			
	01/05/87		4.7			
	02/25/87		4.4			
	03/27/87		5.3			
	04/20/87		4.9			
	04/20/87		4.9			
	05/19/87		6.3			
	05/19/87		6.0			
	05/20/87		6.3			
	05/20/87		6.0			
	06/16/87		5.9			
	07/21/87		3.8			
	08/24/87		6.5			
	09/23/87		8.1			
	10/20/87		5.5			
	11/13/87		3.4			
	12/18/87		3.4			
	01/20/88		5.1			
	02/18/88		5.8			
	03/21/88		8.4			
	04/22/88		2.8			
	05/23/88		3.6			
	06/23/88		4.6			
	07/19/88		4.3			
	08/24/88		4.9			
	09/19/88		5.3			
	10/24/88		5.5			
	11/21/88		5.2			
	12/23/88		5.0			
FPT-1A	09/28/82	<0.02	<0.02	<0.004	<0.02	
	05/18/83	<0.04	<0.04	<0.005	<0.02	
	03/21/84		<0.01		<0.05	
FPT-1B	09/28/82	<0.02	<0.02	<0.004	<0.02	
	05/18/83	<0.04	<0.04	<0.005	<0.02	
	03/21/84	<0.04	<0.01		<0.05	
	03/21/84		<0.01		<0.05	
FPT-2A	01/19/88		<0.02			
FPT-2B	05/18/83	<0.04	<0.04	<0.005	<0.02	
	03/21/84	<0.005	<0.005	<0.005	<0.01	
	03/21/84		<0.01		<0.05	

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TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	DISSOLVED CHROMIUM TOTAL	ARSENIC	COPPER	COMMENTS
FPT-3	08/31/00	0.44				
	09/20/82	0.48	0.48		<0.02	
	05/18/83	0.17	0.17		<0.02	
	06/16/83		0.21		<0.02	
	08/13/83	0.062	0.65		<0.05	
	08/13/83	0.62	0.65		<0.05	
	10/04/83	0.44	1.4	0.041	0.95	
	12/08/83	0.11	0.12		<0.02	
	01/06/84	0.06	0.06		<0.02	
	01/18/84	0.09	0.12		<0.02	
	01/24/84	0.16	0.16		<0.02	
	02/01/84	0.20	0.20		<0.02	
	03/01/84	0.10	0.10		<0.02	
	03/21/84		0.071		<0.05	
	03/21/84	0.098	0.12		<0.01	
	04/02/84	0.13	0.16		<0.02	
	12/04/84	0.08	0.08		<0.02	
	01/03/85	0.35	0.35		<0.02	
	01/30/85		0.12			
	03/01/85		0.11			
	04/01/85		0.10			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85		<0.02			
	09/09/85		0.07			
	09/20/85		<0.02			
	10/01/85		<0.02			
	10/[illegible]1/85		<0.02			
	12/04/85		0.02			
	01/02/86		0.06			
	02/13/86		<0.02			
	03/14/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	12/03/86		<0.02			
	01/05/87		<0.02			
	02/25/87		0.03			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/22/87		<0.02			
	08/24/87		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
FPT-3	09/23/87		<0.02			
	10/20/87		<0.02			
	11/13/87		<0.02			
	12/18/87		0.04			
	01/19/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/25/88		<0.02			
	05/23/88		<0.02			
	06/24/88		<0.02			
	07/20/88		<0.02			
	08/24/88		<0.02			
	09/19/88		<0.02			
	10/25/88		<0.02			
	11/21/88		<0.02			
	12/29/88		<0.02			
FPT-4	08/31/00	<0.005				
	06/16/83		0.27		0.15	
	10/04/83	<0.005	0.014	0.02	0.10	
	12/08/83	0.16	0.20		<0.02	
	01/24/84	0.14	0.16		<0.02	
	03/01/84	<0.02	<0.02	<0.004	<0.02	
	03/21/84	0.037	0.03		<0.01	
	03/21/84		0.027		<0.05	
	01/30/85		0.04			
	05/03/85		<0.02			
	08/01/85		<0.02			
	10/31/85		<0.02			
	02/13/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	07/22/87		<0.02			
	10/20/87		<0.02			
	01/19/88		<0.02			
	04/25/88		<0.02			
	07/20/88		<0.02			
	10/25/88		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	DISSOLVED CHROMIUM TOTAL	ARSENIC	COPPER	COMMENTS
FPT-5	08/31/00	<0.005				
	06/16/83		0.75	0.007	0.31	
	08/13/83	0.58	0.62	0.004	0.05	
	10/04/83	<0.005	<0.005	0.001	<0.05	
	12/08/83	0.9	0.90		<0.02	
	01/06/84	0.02	0.20		<0.02	
	01/18/84	0.36	0.51	0.01	<0.02	
	01/24/84	0.45	0.59		<0.02	
	02/01/84	0.2	0.40		<0.02	
	03/01/84	<0.02	<0.02	<0.004	0.02	
	03/21/84		0.32	0.04	<0.05	
	03/21/84	0.34	0.40		<0.01	
	04/02/84	<0.02	0.04	<0.004	<0.02	
	12/04/84	0.02	0.02		<0.02	
	01/03/85	0.1	0.10		<0.02	
	01/30/85		0.16			
	03/01/85		0.27			
	04/01/85		0.22			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85		<0.02			
	09/09/85		<0.02			
	10/01/85		<0.02			
	10/31/85		<0.02			
	12/04/85		<0.02			
	01/02/86		<0.02			
	02/13/86		<0.02			
	03/14/86		<0.02			
	05/01/86		<0.02			
	08/13/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	12/03/86		<0.02			
	01/05/87		<0.02			
	02/25/87		<0.02			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/22/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/20/87		<0.02			
	11/13/87		<0.02			
	12/18/87		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
FPT-5	01/19/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/25/88		<0.02			
	05/23/88		<0.02			
	06/24/88		<0.02			
	07/20/88		<0.02			
	08/24/88		<0.02			
	09/19/88		<0.02			
	10/25/88		<0.02			
	11/21/88		<0.02			
	12/29/88		<0.02			

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TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	DISSOLVED CHROMIUM TOTAL	ARSENIC	COPPER	COMMENTS
AT-1	08/31/00	<0.005				
	10/03/83	<0.05	<0.005	0.003	<0.05	
	01/18/84	<0.01	<0.05	<0.05	<0.02	
	01/24/84	0.01	0.012		<0.02	
	02/01/84	0.03	<0.05		<0.02	
	03/01/84	<0.02	<0.02	<0.004	0.02	
	03/21/84	0.03	0.06		<0.01	
	03/21/84		0.021		<0.05	
	04/02/84	0.04	0.05		<0.02	
	12/04/84	<0.02	<0.02	<0.004	<0.02	
	01/03/85	0.03	0.03		<0.02	
	01/30/85		0.04			
	03/01/85		0.03			
	03/01/85		0.03			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85		<0.02			
	09/09/85		0.03			
	10/01/85		<0.02			
	10/31/85		<0.02			
	10/31/85	0.13	0.13			
	12/04/85		<0.02			
	01/02/86		<0.02			
	04/03/86		<0.02			
	05/01/86		<0.02			
	08/03/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	12/03/86		<0.02			
	01/05/87		<0.02			
	02/25/87		<0.02			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/23/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/20/87		<0.02			
	11/13/87		<0.02			
	12/18/87		<0.02			
	01/19/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/25/88		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
AT-1	05/23/88		<0.02			
	06/24/88		<0.02			
	07/20/88		<0.02			
	08/23/88		<0.02			
	09/20/88		<0.02			
	10/25/88		<0.02			
	11/21/88		<0.02			
	12/29/88		<0.02			

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GEOSYSTEM

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
AT-2	08/31/00	<0.005				
	10/03/83	<0.05	0.42	0.046	0.22	
	01/24/84	0.07	0.09		<0.02	
	01/25/84	<0.01	<0.05	<0.05	<0.02	
	02/01/84	0.03	<0.05		<0.02	
	03/12/84	0.04	0.04		<0.02	
	03/21/84		0.054		<0.05	
	03/21/84	0.07	0.10		<0.01	
	04/02/84	0.04	0.05		<0.02	
	01/30/85		0.12			
	03/01/85		0.11			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85		<0.02			
	09/09/85		0.18			
	09/20/85		0.11			
	10/01/85		0.10			
	12/04/85		0.11			
	01/02/86		0.13			
	05/01/86		0.06			
	08/13/86		0.05			
	09/03/86		0.13			
	10/06/86		0.09			
	12/03/86		0.08			
	01/05/87		0.09			
	02/25/87		0.05			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		0.05			
	07/23/87		<0.02			
	08/24/87		<0.02			
	09/23/87		0.09			
	10/20/87	0.03	0.03			
	11/13/87		0.05			
	12/18/87		0.04			
	01/19/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/25/88		0.05			
	05/23/88		0.05			
	06/24/88		<0.02			
	07/20/88		<0.02			
	08/23/88		0.04			
	09/20/88		<0.02			

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TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
AT-2	10/25/88		0.03			
	11/21/88		<0.02			
	12/29/88		<0.02			

DRAFT

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
AT-3	01/24/84	<0.005	<0.005	<0.005	<0.02	
	02/08/84	<0.01	<0.05	<0.05	0.02	
	03/21/84		<0.01		<0.05	
	03/21/84	<0.005	<0.005	<0.005	<0.01	
	01/18/85	<0.02	<0.02	<0.004	0.02	
	01/30/85					INACCESSIBLE
	03/01/85		<0.02			
	05/03/85		<0.02			
	07/02/85		<0.02			
	08/01/85		<0.02			
	09/09/85		<0.02			
	10/01/85		<0.02			
	10/31/85	<0.02	<0.02			
	01/02/86		<0.02			
	05/01/86					INACCESSIBLE
	08/13/86		<0.02			
	09/03/86		<0.02			
	10/06/86		<0.02			
	12/03/86		<0.02			
	01/05/87		<0.02			
	02/25/87		<0.02			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/23/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/20/87		<0.02			
	11/13/87		<0.02			
	12/18/87		<0.02			
	01/19/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/25/88		<0.02			
	05/23/88		<0.02			
	06/24/88		0.10			
	07/20/88		<0.02			
	08/23/88		<0.02			
	09/20/88		<0.02			
	10/25/88		<0.02			
	11/21/88		<0.02			
	12/29/88		<0.02			

TABLE B.2
(continued)

WELL	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
AT-4	01/05/87		<0.02			
	02/25/87		<0.02			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	07/23/87		<0.02			
	10/20/87		<0.02			
	01/19/88		<0.02			
	04/25/88		<0.02			
	07/20/88		<0.02			
	10/25/88		<0.02			
AT-5	01/05/87		<0.02			
	02/25/87		<0.02			
	03/26/87		<0.02			
	04/20/87		<0.02			
	05/19/87		<0.02			
	05/20/87		<0.02			
	06/16/87		<0.02			
	07/23/87		<0.02			
	08/24/87		<0.02			
	09/23/87		<0.02			
	10/20/87		<0.02			
	11/13/87		<0.02			
	12/18/87		<0.02			
	01/19/88		<0.02			
	02/18/88		<0.02			
	03/21/88		<0.02			
	04/25/88		<0.02			
	05/23/88		<0.02			
	06/24/88		<0.02			
	07/20/88		<0.02			
	08/23/88		<0.02			
	09/20/88		<0.02			
	10/25/88		<0.02			
	11/21/88		<0.02			
	12/29/88		<0.02			

APPENDIX C

STORM WATER QUALITY DATA

DRAFT

GEOSYSTEM

TABLE C.1

STORM WATER QUALITY DATA
(All units are mg/l)

SAMPLING STATION	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
C-100	01/31/00		0.02	0.10		
	01/21/83		0.03		<0.02	
	01/28/83		<0.02		<0.02	
	02/09/83		0.03		<0.02	
	03/24/83		0.02	0.005	<0.02	
	05/18/83	0.04	0.04	0.005	<0.02	
	11/03/83	0.08	0.10	0.051	0.07	
	11/10/83	0.05	0.15	0.058	0.09	
	11/17/83	<0.01	0.07	<0.05	0.03	
	12/05/83	0.02	0.48	0.53	0.40	
	12/29/83	<0.01	<0.05	<0.01	<0.02	
	01/16/84	<0.01	<0.05	<0.05	<0.02	
	02/10/84	0.10	0.10		0.03	
	02/21/84	0.04	0.04	0.007	0.02	
	02/21/84	0.04	0.04	0.007	0.02	
	03/13/84	0.38	0.38	0.043	0.06	
	10/11/84					
	10/16/84	<0.02	0.05	0.03	0.06	
	11/15/84	<0.02	0.02	0.02	0.03	
	11/27/84	0.02	0.02		0.04	
	12/03/84	<0.02	<0.02	<0.004	0.02	
	12/10/84	<0.02	<0.02	0.004	<0.02	
	10/21/85		0.08	0.04		
	11/25/85		0.03	0.03		
	12/02/85		0.04	0.04		
	01/16/86		0.02	0.02		
	02/03/86		<0.02			
	04/15/86		0.09	0.05		
	12/23/86		0.04	0.006		
	01/03/87		0.02	<0.004		
	01/28/87		<0.02	0.01		
	10/22/87		<0.02	0.024		
	10/28/87		<0.02	0.013		
	12/04/87		<0.02	<0.004		
	01/04/88		<0.02	<0.004		
	11/13/88		<0.02	0.008		
	11/16/88		<0.02	0.012		
	12/20/88		<0.02	0.007		

GEOSYSTEM

TABLE C.1
(continued)

SAMPLING STATION	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
NE	01/31/00		0.06	0.05		
	01/21/83		0.02		0.02	
	01/28/83		<0.02		<0.02	
	02/09/83		0.02		<0.02	
	03/24/83		0.12	0.055	0.06	
	05/18/83	<0.04	<0.04	<0.005	<0.02	
	11/03/83	0.06	0.15	0.041	0.10	
	11/10/83	0.08	2.20	0.54	1.12	
	11/17/83	<0.01	0.32	0.14	0.23	
	12/05/83	0.24	1.10	0.38	0.70	
	12/29/83	<0.01	<0.05	<0.01	<0.02	
	01/16/84	0.10	0.20		<0.02	
	02/10/84	0.04	<0.05		<0.02	
	02/21/84	0.04	0.07	0.027	0.04	
	03/13/84	0.63	0.79	0.08	0.10	
	10/11/84	<0.02	0.06	0.008	0.03	
	10/16/84	<0.02	<0.02	0.009	<0.02	
	11/15/84	<0.02	<0.02	<0.004	0.03	
	11/27/84	<0.02	<0.02	<0.004	0.03	
	12/03/84	0.02	0.02		0.02	
	12/10/84	<0.02	0.02	<0.004	<0.02	
	10/21/85		0.02	0.02		
	11/25/85		0.02	0.02		
	12/02/85		0.05	0.05		
	01/16/86		<0.02			
	02/05/86		<0.02			
	04/16/86		0.14	0.04		
	12/23/86		0.04	0.006		
	01/03/87		0.02	<0.004		
	01/28/87		0.04	0.01		
	10/22/87		0.05	0.017		
	10/28/87		<0.02	0.01		
	12/04/87		<0.02	<0.004		
	01/04/88		<0.02	<0.004		
	11/13/88		<0.02	<0.004		
	11/16/88		<0.02	0.005		
	12/20/88		<0.02	<0.004		

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TABLE C.1
(continued)

SAMPLING STATION	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
NW	01/31/00		<0.02			
	01/21/83		<0.02		<0.02	
	01/28/83		<0.02		<0.02	
	02/09/83		<0.02		<0.02	
	03/24/83		<0.02		<0.02	
	05/18/83	<0.04	<0.04	<0.005	<0.02	
	11/03/83	0.05	0.05	0.005	<0.05	
	11/10/83	0.01	0.014		<0.05	
	11/17/83	<0.01	<0.05	<0.05	<0.02	
	12/05/83	<0.01	<0.05	<0.05	<0.02	
	12/29/83	<0.01	<0.05	<0.01	<0.02	
	01/16/84	<0.01	<0.05	<0.05	<0.02	
	02/10/84	<0.01	<0.05	<0.05	<0.02	
	02/21/84	<0.02	<0.02	<0.004	<0.02	
	03/13/84	<0.02	<0.02	<0.004	<0.02	
	10/11/84	<0.02	<0.02	<0.004	<0.02	
	10/16/84	<0.02	<0.02	<0.004	<0.02	
	11/15/84	<0.02	<0.02	<0.004	<0.02	
	11/27/84	<0.02	<0.02	<0.004	0.02	
	12/03/84	<0.02	<0.02	<0.004	<0.02	
	12/10/84	<0.02	<0.02	<0.004	<0.02	
	10/21/85		<0.02			
	11/25/85		<0.02			
	12/02/85		<0.02			
	01/16/86		<0.02	0.006		
	02/03/86		<0.02			
	04/16/86		<0.02			
	12/[illegible]3/86		<0.02	<0.004		
	01/03/87		<0.02	<0.004		
	01/28/87		<0.02	<0.004		
	10/22/87		<0.02	<0.010		
	10/28/87		<0.02	<0.01		
	12/04/87		<0.02	<0.004		
	01/04/88		<0.20	<0.004		
	11/13/88		<0.02	<0.004		
	11/16/88		<0.02	<0.004		
	12/20/88		<0.02	<0.004		

TABLE C.1
(continued)

SAMPLING STATION	DATE	DISSOLVED CHROMIUM Cr(VI)	TOTAL	ARSENIC	COPPER	COMMENTS
SE	01/21/83		<0.02		<0.02	
	01/21/83		<0.02		<0.02	
	01/28/83		<0.02		<0.02	
	02/09/83		<0.02		<0.02	
	03/24/83		<0.02		<0.02	
	05/18/83	<0.04	<0.04	<0.005	<0.02	
	11/03/83	0.01	0.017	0.002	<0.05	
	11/10/83	0.10	0.15	0.045	0.07	
	11/17/83	<0.01	0.06	<0.05	0.02	
	12/05/83	0.02	0.15	0.16	0.10	
	12/29/83	<0.01	<0.05	<0.01	<0.02	
	01/16/84	<0.01	<0.05	<0.05	<0.02	
	02/10/84	<0.01	<0.05	<0.05	<0.02	
	02/21/84	<0.02	<0.02	<0.004	<0.02	
	03/13/84	0.02	0.02		0.02	
	10/11/84					
	10/16/84	<0.02	<0.02	<0.004	0.02	
	11/15/84	<0.02	<0.02	<0.004	<0.02	
	11/27/84	<0.02	<0.02	<0.004	0.02	
	12/03/84	<0.02	<0.02	<0.004	<0.02	
	12/10/84	<0.02	<0.02	<0.004	<0.02	
SW	01/21/83		<0.02		<0.02	
	01/28/83		<0.02		<0.02	
	02/09/83		<0.02		<0.02	
	03/24/83		<0.02		<0.02	
	05/18/83	<0.04	<0.04	<0.005	<0.02	
	11/03/83	0.02	0.017	0.002	<0.05	
	11/10/83	0.01	0.017	0.002	<0.05	
	11/17/83	<0.01	<0.05	<0.05	<0.02	
	12/05/83	<0.01	<0.05	<0.05	<0.02	
	12/29/83	<0.01	<0.05	<0.01	<0.02	
	01/16/84	<0.01	<0.05	<0.05	<0.02	
	02/10/84	<0.01	<0.05	<0.05	<0.02	
	02/21/84	<0.02	<0.02	<0.004	<0.02	
	03/13/84	<0.02	<0.02	<0.004	0.02	
	10/11/84					
	10/16/84					
	11/15/84	<0.02	<0.02	<0.004	<0.02	
	11/27/84	<0.02	<0.02	<0.004	0.02	
	12/03/84	<0.02	<0.02	<0.004	<0.02	
	12/10/84	<0.02	<0.02	<0.004	<0.02	

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APPENDIX D

SOIL CHEMICAL DATA

DRAFT

GEOSYSTEM

TABLE D.1

RESULTS OF SOIL CHEMICAL ANALYSES

LOCATION	SAMPLE I.D.	CONCENTRATION (ppm)		
		CHROMIUM	ARSENIC	COPPER
Upgradient	S-1, 1'	15	2.5	5.4
	S-1, 3'	26	12	13
	S-1, 6'	36	11	17
	S-1, 10'	32	12	19
	S-1, 15'	49	12	20
	S-1, 20'	23	6.0	13
Treated Wood Storage Area	S-2, 1'	29	--(1)	--
	S-2, 3'	23	--	--
	S-2, 6'	36	--	--
	S-2, 10'	50	--	--
	S-2, 15'	44	--	--
	S-2, 20'	25	--	--
	S-3, 1'	28	--	--
	S-3, 3'	29	--	--
	S-3, 6'	25	--	--
	S-3, 10'	31	--	--
	S-3, 15'	32	--	--
	S-3, 20'	27	--	--
	S-4, 1'	210	220	170
	S-4, 3'	50	11	26
	S-4, 6'	46	--	--
	S-4, 10'	31	--	--
	S-4, 15'	52	12	20
	S-4, 20'	39	--	--
Retort and Sump Area	S-5, 0'	130	15	69
	S-5, 1'	130	14	79
	S-5, 3'	26	6.7	17
	S-5, 6'	39	7.8	18
	S-5, 10'	32	7.0	20
	S-5, 15'	42	5.8	16
	S-5, 20'	29	5.7	16
	S-6, 0'	48	7.5	22
	S-6, 1'	10	9.5	10
	S-6, 3'	53	6.1	15
	S-6, 6'	34	3.1	15
	S-6, 10'	58	5.5	17
	S-6, 15'	50	4.6	18
	S-6, 20'	27	5.1	17

TABLE D.1
(Continued)

LOCATION	SAMPLE I.D.	CONCENTRATION (ppm) CHROMIUM	ARSENIC	COPPER
Retort and Sump Area (continued)	S-7, 0'	23	3.1	11
	S-7, 1'	53	4.8	9.0
	S-7, 3'	25	11	16
	S-7, 6'	26	12	16
	S-7, 10'	33	7.7	17
	S-7, 15'	41	10	17
	S-7, 20'	31	8.3	19
	S-8, 0'	160	38	91
	S-8, 1'	38	13	22
	S-8, 3'	38	7.3	20
	S-8, 6'	23	6.1	9.6
	S-8, 10'	100	14	24
	S-8, 15'	53	14	21
	S-8, 20'	35	12	21
	S-10, 0'	32	15	14
	S-10, 1'	34	9.0	19
	S-10, 3'	38	11	17
	S-10, 6'	32	7.2	13
	S-10, 10'	40	11	17
	S-10, 15'	75	7.9	17
	S-10, 20'	29	10	20
Unpaved and Untreated Wood Storage Area	S-11, 1'	19	--	--
	S-11, 3'	24	--	--
	S-11, 6'	47	--	--
	S-11, 10'	39	--	--
	S-11, 15'	43	--	--
	S-11, 20'	34	--	--
	S-12, 1'	110	12	20
	S-12, 3'	53	9.2	18
	S-12, 6'	50	11	17
	S-12, 10'	38	--	--
	S-12, 15'	44	--	--
	S-12, 20'	29	--	--
	S-13, 1'	18	--	--
	S-13, 3'	26	--	--
	S-13, 6'	66	9.0	20
	S-13, 10'	35	--	--
	S-13, 15'	49	--	--
	S-13, 20'	30	--	--

TABLE D.1
(Continued)

LOCATION	SAMPLE I.D.	CONCENTRATION (ppm) CHROMIUM	ARSENIC	COPPER
Unpaved and Untreated Wood Storage Area (continued)	S-14, 1'	43	11	18
	S-14, 3'	79	6.6	14
	S-14, 6'	25	--	--
	S-14, 10'	44	--	--
	S-14, 15'	32	--	--
	S-14, 20'	27	--	--
	S-15, 1'	43	--	--
	S-15, 3'	22	--	--
	S-15, 6'	42	--	--
	S-15, 10'	38	--	--
	S-15, 15'	29	--	--
	S-15, 20'	28	--	--
	S-16, 1'	22	6.3	12
	S-16, 3'	19	5.9	10
	S-16, 6'	32	11	15
	S-16, 10'	35	8.6	17
	S-16, 15'	29	9.7	12
	S-16, 20'	35	10	15
	S-17, 1'	26	--	--
	S-17, 3'	33	--	--
	S-17, 6'	35	--	--
	S-17, 10'	43	--	--
	S-17, 15'	37	--	--
	S-17, 20'	18	--	--
	S-18, 1'	28	--	--
	S-18, 3'	21	--	--
	S-18, 6'	34	--	--
	S-18, 10'	37	--	--
	S-18, 15'	28	--	--
	S-18, 20'	31	--	--
Off-site and Downgradient Areas	S-19, 1'	29	3.9	13
	S-19, 6'	26	9.1	18
	S-19, 10'	17	3.6	6.6
	S-19, 15'	38	8.1	17
	S-19, 20'	48	13	17
	S-20, 1'	31	--	--
	S-20, 3'	25	--	--
	S-20, 6'	22	--	--
	S-20, 10'	15	--	--
	S-20, 15'	48	--	--
	S-20, 20'	41	--	--

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TABLE D.1
(Continued)

LOCATION	SAMPLE I.D.	CONCENTRATION (ppm) CHROMIUM	ARSENIC	COPPER
Off-site and Downgradient Areas (continued)	S-21, 1'	85	17	21
	S-21, 3'	33	--	--
	S-21, 6'	47	--	--
	S-21, 10'	40	--	--
	S-21, 15'	39	--	--
	S-21, 20'	47	--	--
	S-22, 1'	24	--	--
	S-22, 3'	33	--	--
	S-22, 6'	36	--	--
	S-22, 10'	59	14	19
	S-22, 15'	32	--	--
	S-22, 20'	28	--	--
	S-23, 1'	25	11	13
	S-23, 3'	69	5.4	16
	S-23, 6'	43	8.0	18
	S-23, 10'	53	11	14
	S-23, 15'	29	11	11
	S-23, 20'	25	7.8	9.7
	S-24, 1'	16	8.6	13
	S-24, 3'	32	4.9	17
	S-24, 6'	34	12	17
	S-24, 10'	34	6.1	16
	S-24, 15'	45	9.0	20
	S-24, 20'	38	12	23
	S-25, 1'	9.3	--	--
	S-25, 3'	39	--	--
	S-25, 6'	54	8.2	19
	S-25, 10'	54	9.3	22
	S-25, 15'	29	--	--
	S-25, 20'	39	--	--
	S-26, 1'	31	14	20
	S-26, 3'	30	9.3	17
	S-26, 6'	38	9.6	15
	S-26, 10'	27	6.6	13
	S-26, 15'	42	9.5	18
	S-26, 20'	25	6.8	16

TABLE D.1
(Continued)

LOCATION	SAMPLE I.D.	CONCENTRATION (ppm)		
		CHROMIUM	ARSENIC	COPPER
Throughout the Entire Site	G-1	110	32	60
	G-2	110	140	59
	G-3	60	16	33
	G-4	31	7.3	15
	G-5	150	39	99
	G-6	29	6.5	15
	G-7	43	19	21
	G-8	55	15	36
	G-9, 1'	46	13	24
	G-10, 1'	540	170	230
	G-11, 1'	130	7.3	18
	G-12, 2'	29	15	25
	G-13, 1'	24	8.6	13
	G-14, 1'	24	11	14
	G-15, 1'	45	8.0	16
	G-16, 1'	30	8.5	20
	G-17, 1'	29	12	29

NOTES: 1) -- indicates Not Analyzed.

Reference: D'Appolonia Consulting Engineers, Inc., 1984.

TABLE D.2

CONCENTRATIONS OF Cr, As, AND Cu
IN SHALLOW AND DEEP SOIL SAMPLES

BORING NO.	CHROMIUM (ppm)			ARSENIC (ppm)			COPPER (ppm)		
	1 ft	3 ft	15 ft	1 ft	3 ft	15 ft	1 ft	3 ft	15 ft
S-1	15	26	49	2.5	12	12	5.4	13	20
S-2	29	23	44	--	--	--	--	--	--
S-3	28	29	32	--	--	--	--	--	--
S-4	210	50	52	220	11	12	170	26	20
S-5	130	26	42	14	6.7	5.8	79	17	16
S-6	10	53	50	9.5	6.1	4.6	10	15	18
S-7	53	25	41	4.8	11	10	9	16	17
S-8	38	38	53	13	7.3	14	22	20	21
S-10	34	38	75	9	11	7.9	19	17	17
S-11	19	24	43	--	--	--	--	--	--
S-12	110	53	44	12	9.2	--	20	18	--
S-13	18	26	49	--	--	--	--	--	--
S-14	43	79	32	11	6.6	--	18	14	--
S-15	43	22	29	--	--	--	--	--	--
S-16	22	19	29	6.3	5.9	9.7	12	10	12
S-17	26	33	37	--	--	--	--	--	--
S-18	28	21	28	--	--	--	--	--	--
S-19	29	--	38	3.9	--	8.1	13	--	17
S-20	31	25	48	--	--	--	--	--	--
S-21	85	33	39	17	--	--	21	--	--
S-22	24	33	32	--	--	--	--	--	--
S-23	25	69	29	11	5.4	11	13	16	11
S-24	16	32	45	8.6	4.9	9.0	13	17	20
S-25	9.3	39	29	--	--	--	--	--	--
S-26	31	30	42	14	9.3	9.5	20	17	18

Reference: D'Appolonia Consulting Engineers, Inc., 1984.

TABLE D.3

CONCENTRATIONS OF Cr, As, and Cu IN NEAR-SURFACE SOIL SAMPLES

SAMPLE I.D.	CHROMIUM (ppm)	ARSENIC (ppm)	COPPER (ppm)
G-1	110	32	60
G-2	110	140	59
G-3	60	16	33
G-4	31	7.3	15
G-5	150	39	99
G-6	29	6.5	15
G-7	43	19	21
G-8	55	15	36
G-9, 1'	46	13	24
G-10,1'	540	170	230
G-11,1'	130	7.3	18
G-12,2'	29	15	25
G-13,1'	24	8.6	13
G-14,1'	24	11	14
G-15,1	45	8.0	16
G-16,1'	30	8.5	20
G-17,1'	29	12	29

Reference: D'Appolonia Consulting Engineers, Inc., 1984.

TABLE D.4

CHROMIUM CONCENTRATIONS (ppm) IN SOIL SAMPLES
IN VARIOUS AREAS RELATIVE TO RETORT AND SUMP AREAS

LOCATION	BORING NO.	DEPTH (feet) 0	1	3	6	10	15	20
Upgradient	S-1	--	15	26	36	32	49	23
Background	S-26	--	31	30	38	27	42	25
Retort and Sump Area	S-5	130	130	26	39	32	42	29
	S-8	160	38	38	23	100	53	35
	S-10	32	34	38	32	40	75	29
Downgradient	S-15	--	43	22	42	38	29	28
	S-22	--	24	33	36	59	32	28
	S-25	--	9.3	39	54	54	29	39

D R A F T

Reference: D'Appolonia Consulting Engineers, Inc., 1984.

GEOSYSTEM

TABLE D.5

SUMMARY OF SOIL ANALYSES
FOR CHROMIUM AND ORGANIC CARBON CONTENT

SAMPLE IDENTIFICATION	HEXAVALENT CHROMIUM (ppm)	TOTAL CHROMIUM (ppm)	HEXAVALENT CHROMIUM (%)	ORGANIC CARBON CONTENT (%)
G-10, 1'	3.0	580	0.52	NR(1)
S-1, 1'	NR	NR	NR	0.86
S-4, 1'	1.0	200	0.5	NR
S-5, 1'	1.0	260/260(2)	0.38	NR
S-16, 15'	<1.0	52	2.5	NR
S-17, 10'	NR	NR	NR	<0.10
S-19, 6'	3.0/4.0	58	6.03	NR
S-21, 1'	8.0	69	11.59	NR
S-25, 21'	NR	NR	NR	0.14

D R A F T

NOTES: 1) NR indicates that the corresponding test was not requested by project personnel.
2) The indicated sample was analyzed in duplicate.

Reference: IT Corporation, June 1985

TABLE D.6

RESULTS OF ANALYSIS OF WASTE EXTRACTION TEST LEACHATES

SAMPLE I.D.[3]	WASTE EXTRACTION TEST RESULTS[1] (mg/l) Cr	As	Cu	TOTAL[2] (ppm) Cr	As	Cu
S-1, 6'	<1.0	<2.5	<5.0	36	11	17
S-4, 1'	4.8	<2.5	7.3	210	220	170
S-5, 1'	3.1	<2.5	<5.0	130	14	79
S-16, 15'	<1.0	<2.5	<5.0	29	9.7	12
S-19, 6'	<1.0	<2.5	<5.0	26	9.1	18
S-21, 1'	2.4	<2.5	<5.0	85	17	21
G-10, 1'	4.4	6.8	8.8	540	170	230
STLC[4]	560[5]	5	25	--	--	--
TLC[6]	--	--	--	2,500	500	2,500

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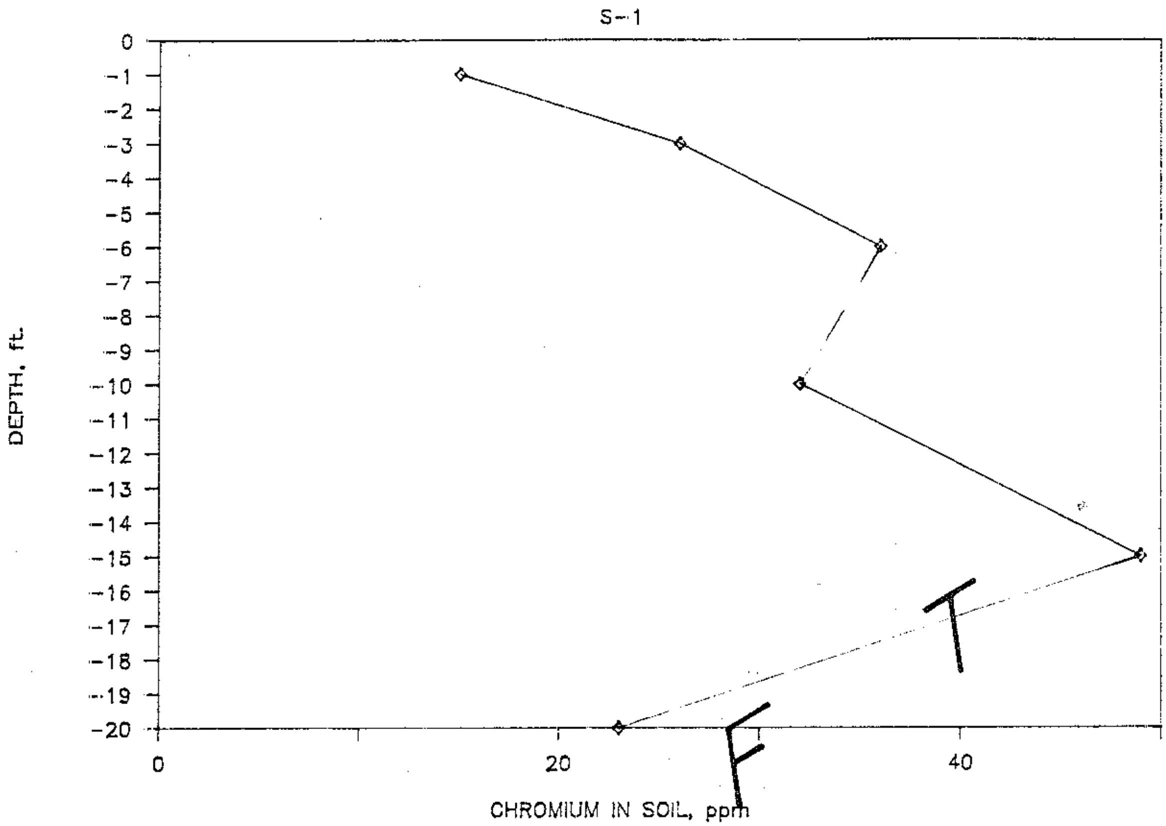
NOTES:
1) The WET procedure followed the most recent (Department of Health Services, January 11, 1984) version of the California Assessment Manual which requires a 48-hour leaching period with a 0.2M sodium citrate solution of pH = 5.
2) Values represent total elemental concentrations in the soil.
3) S represents soil boring samples; G designates a surface soil sample; the first and second numbers refer to the boring number and depth of sampling, respectively.
4) STLC = Soluble Threshold Limit Concentration.
5) It is assumed that all chromium compounds are subject to leaching.
6) TTLC = Total Threshold Limit Concentration.

Reference: IT Corporation, June 1985.

GEOSYSTEM



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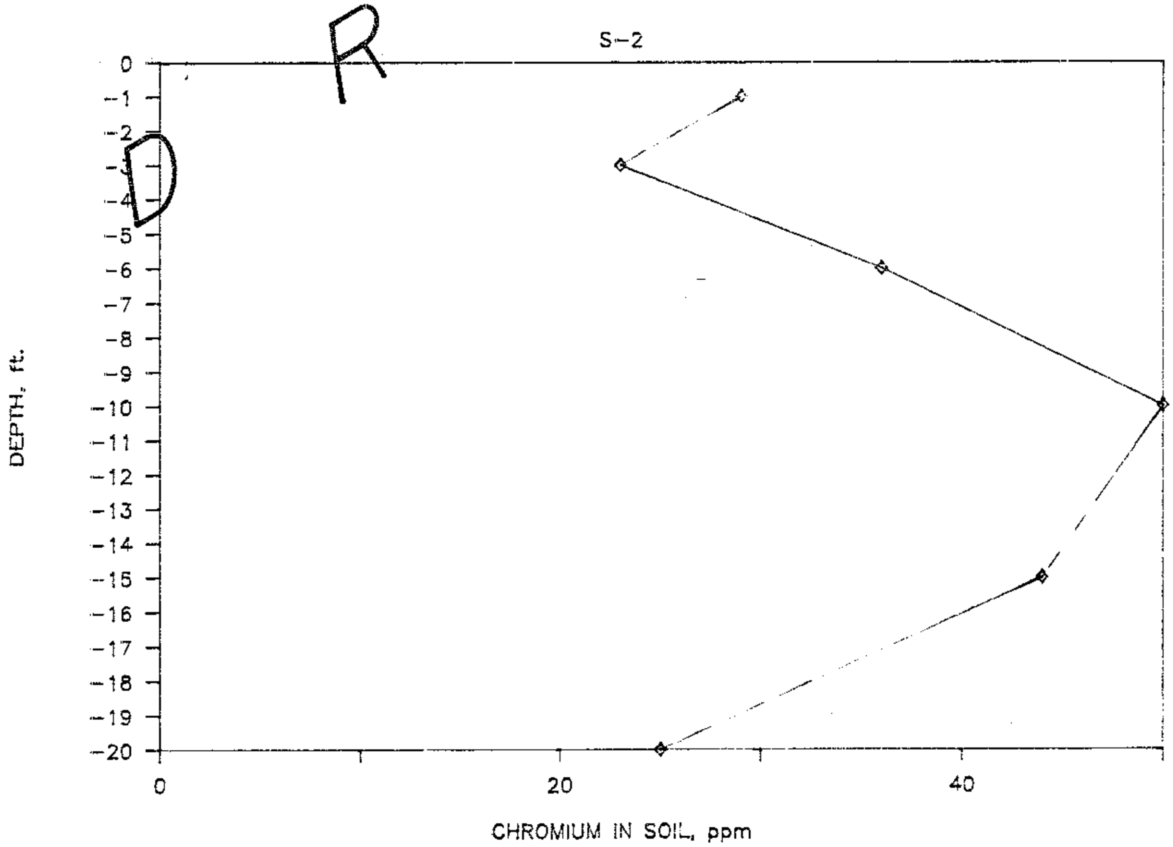

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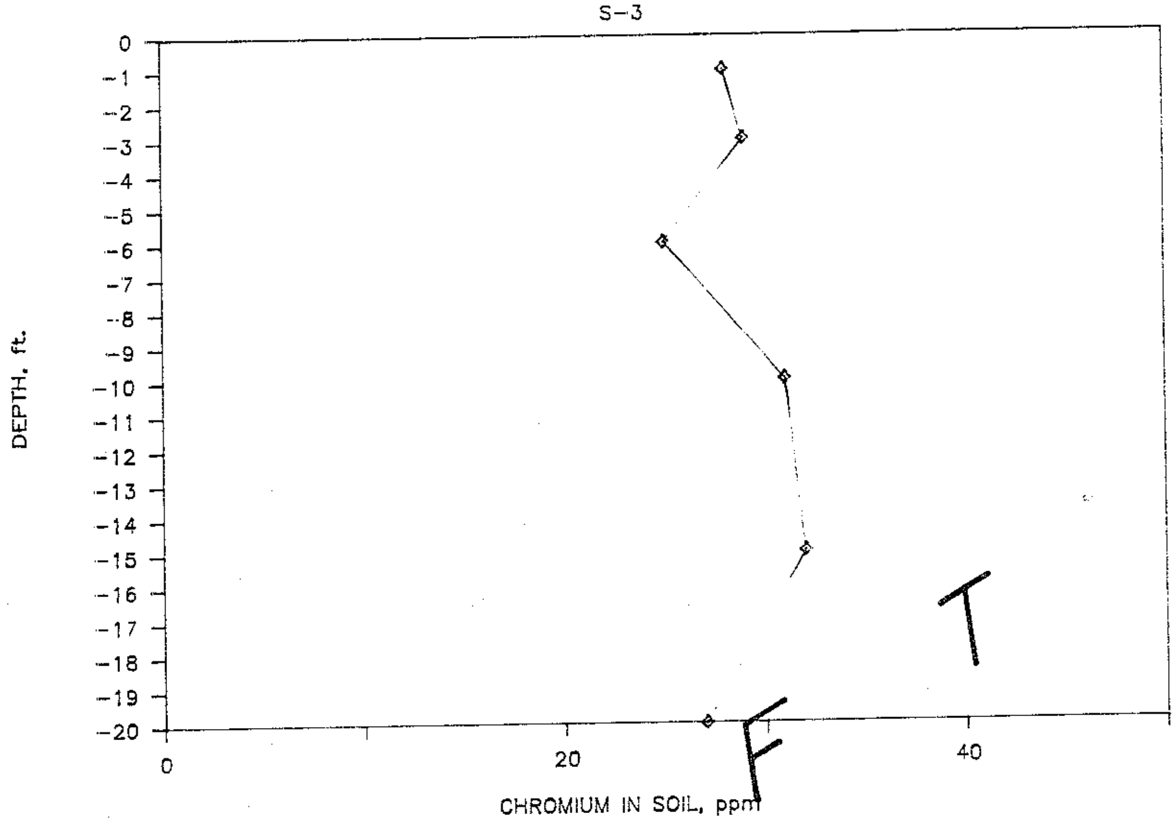
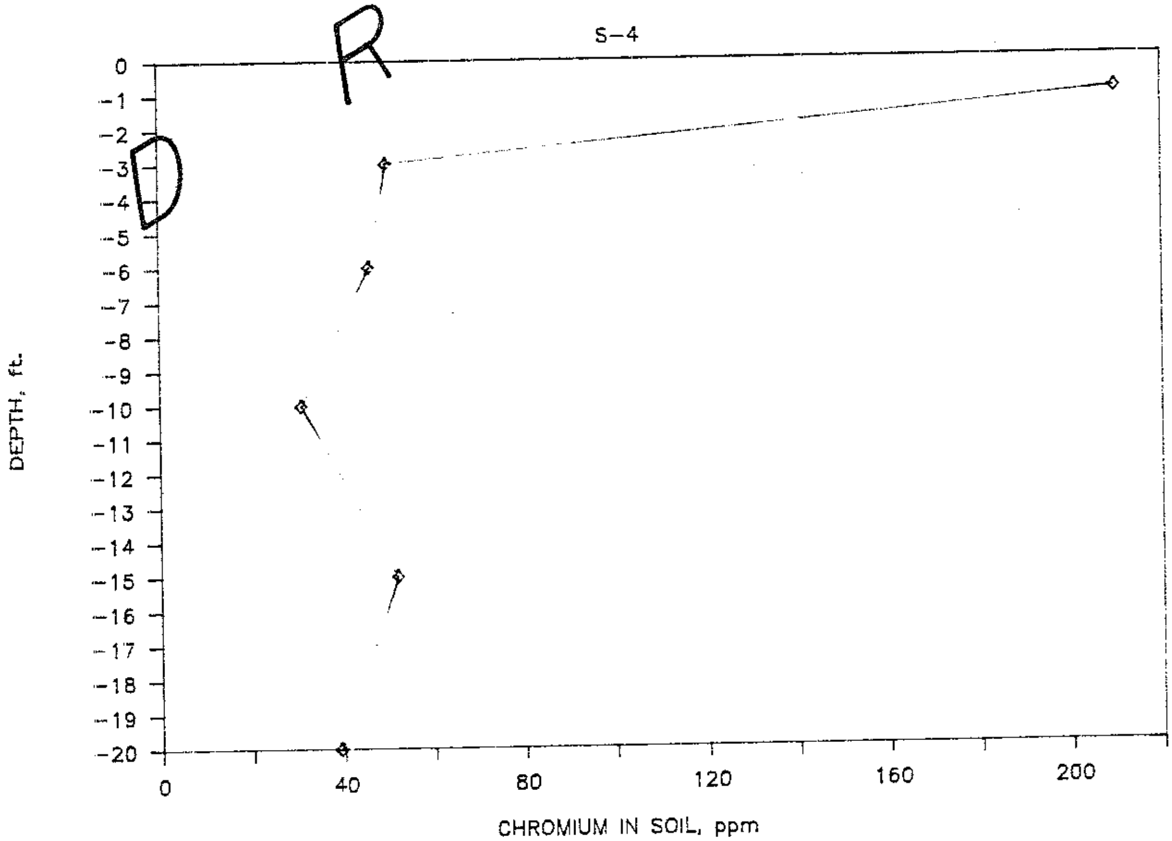


D R A F T



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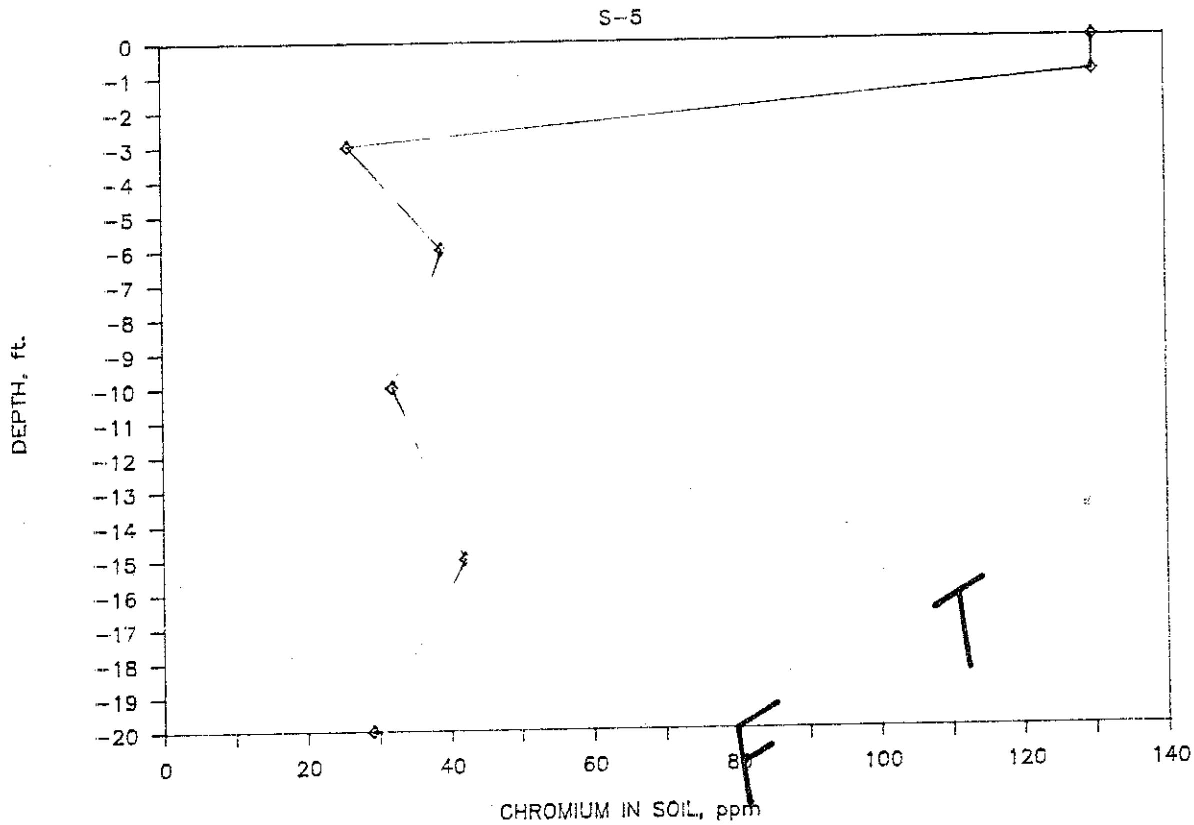

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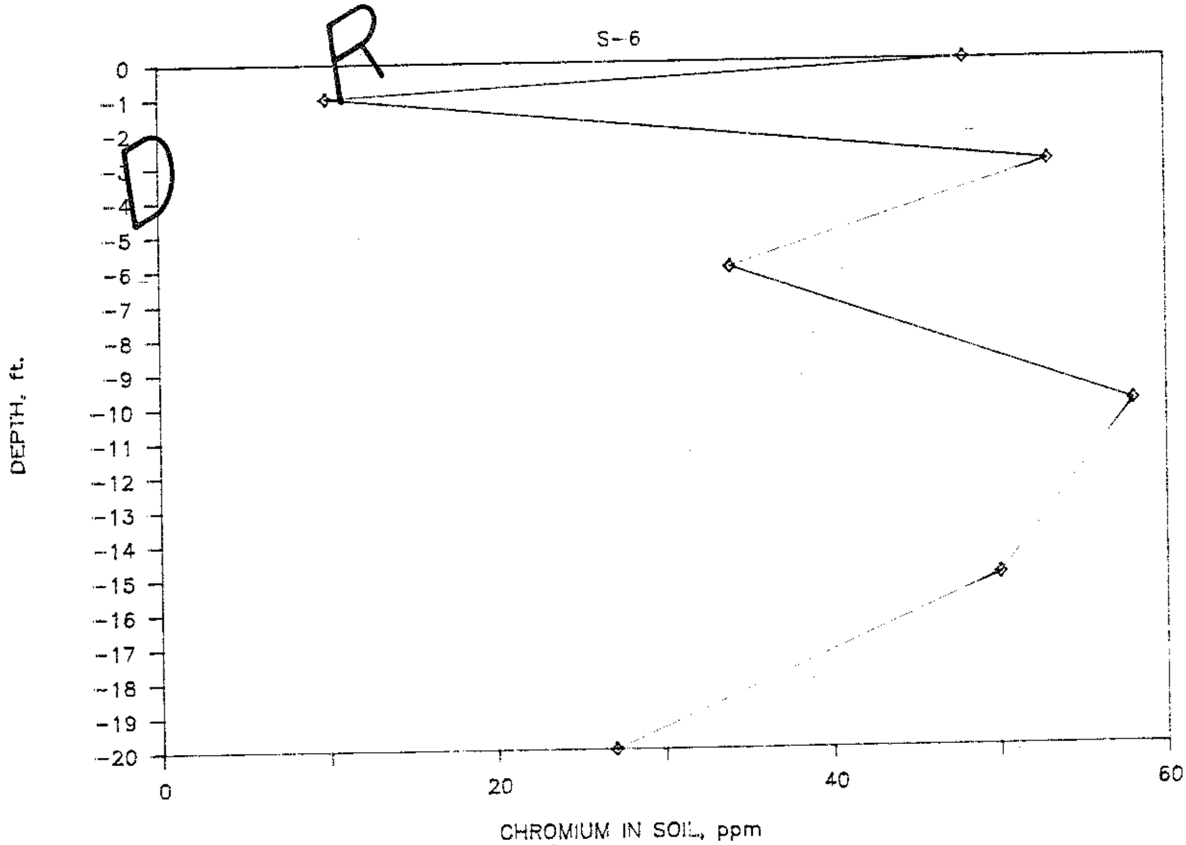

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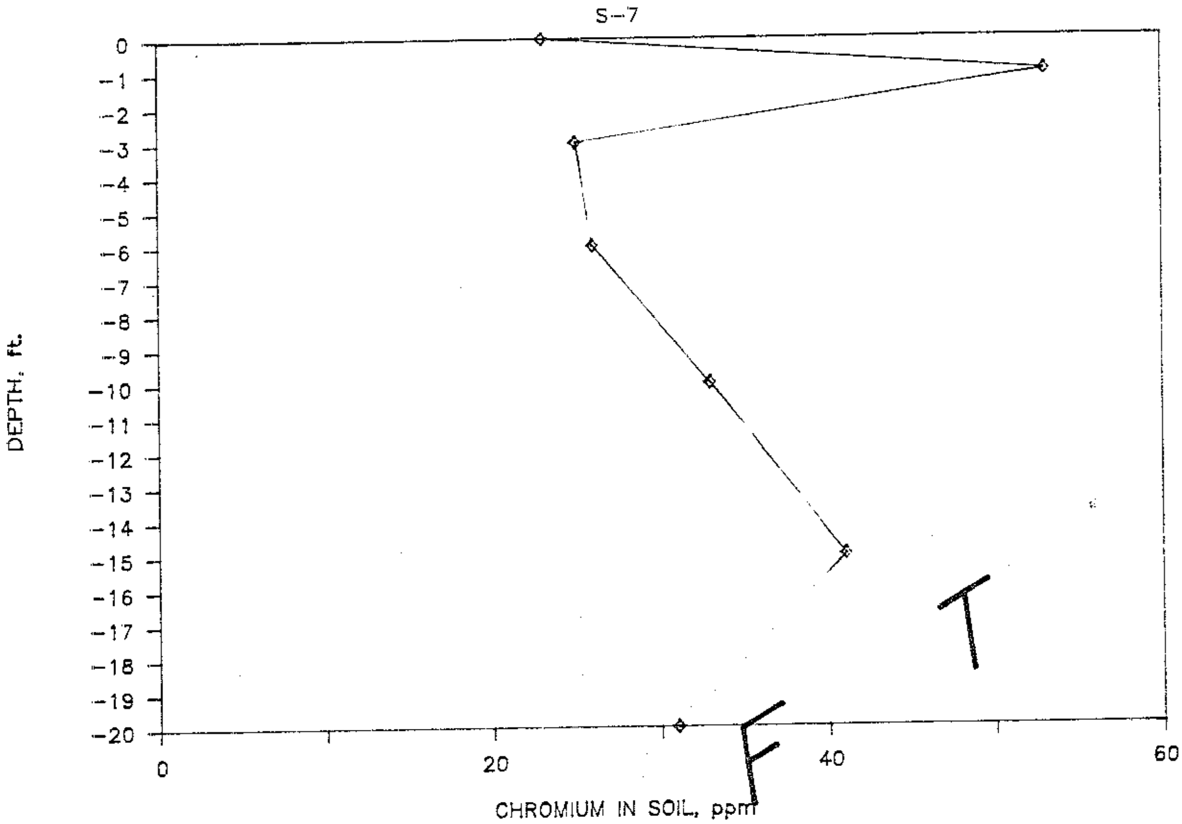

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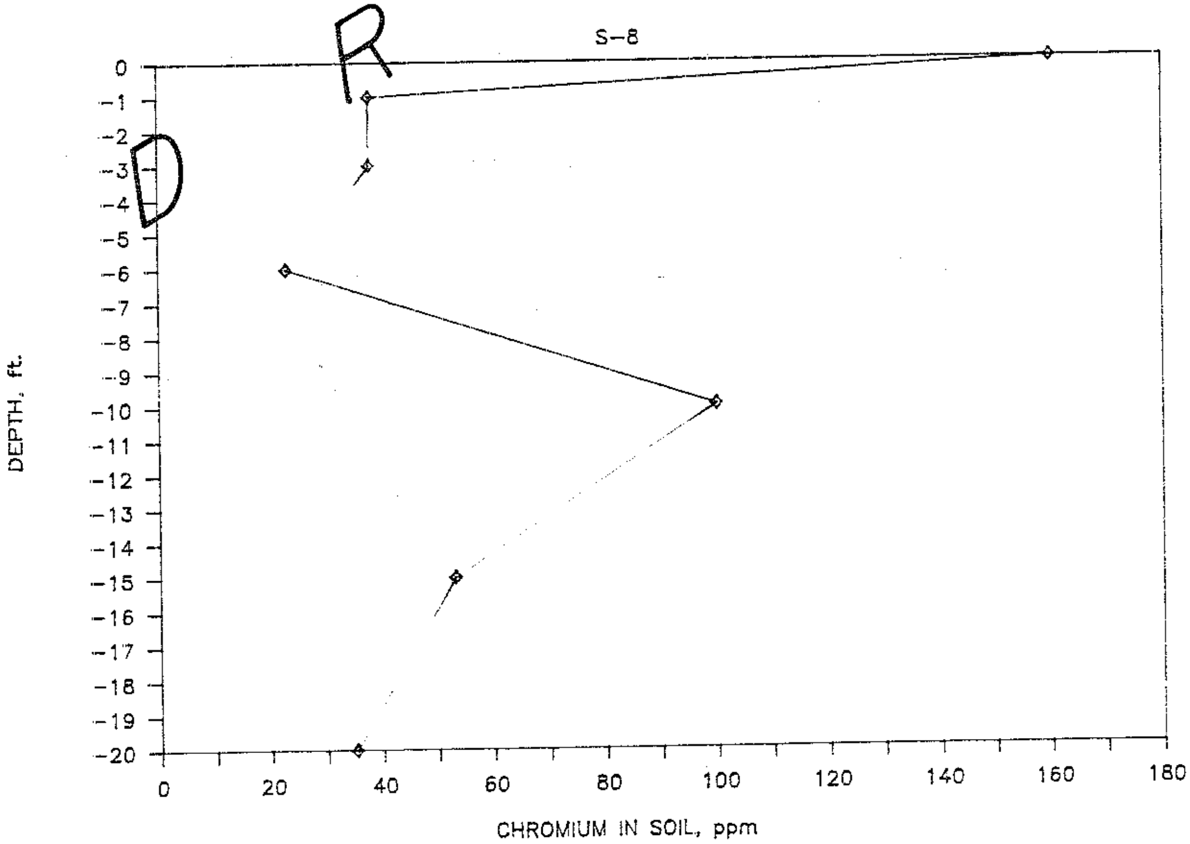

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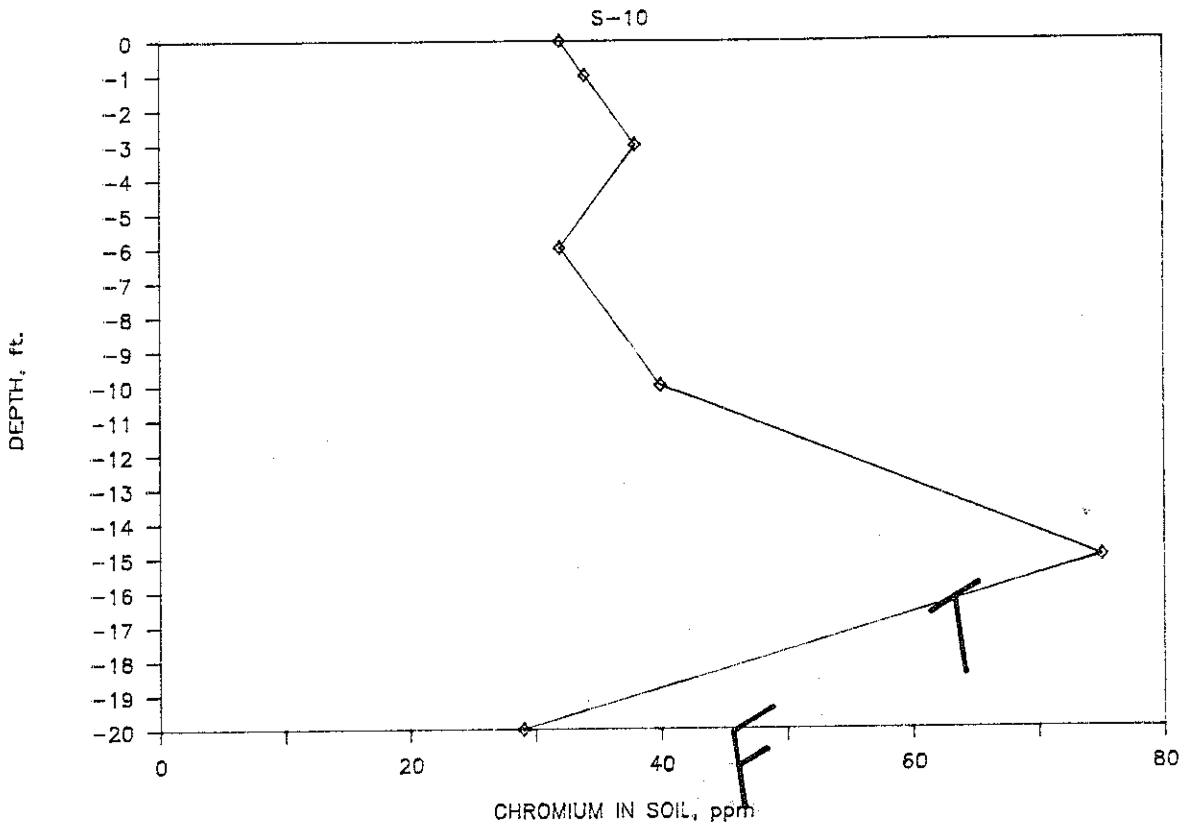

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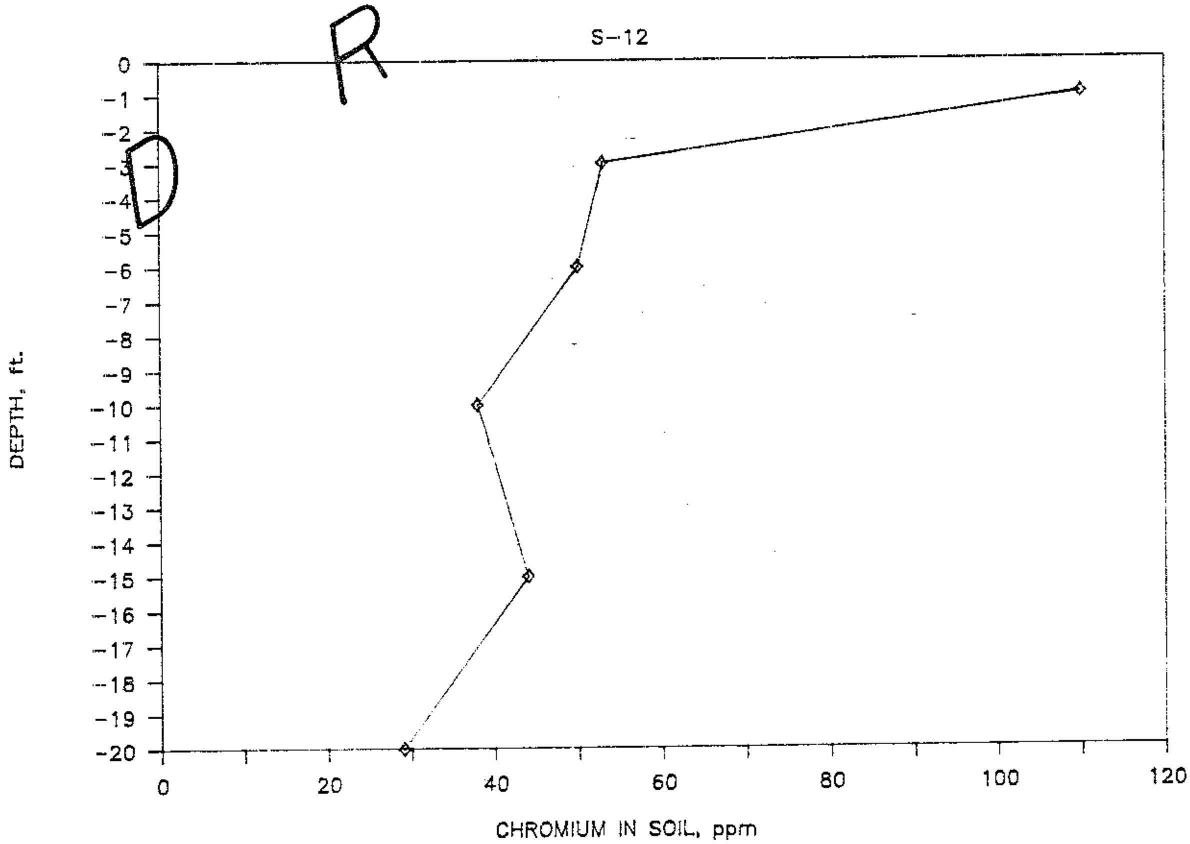

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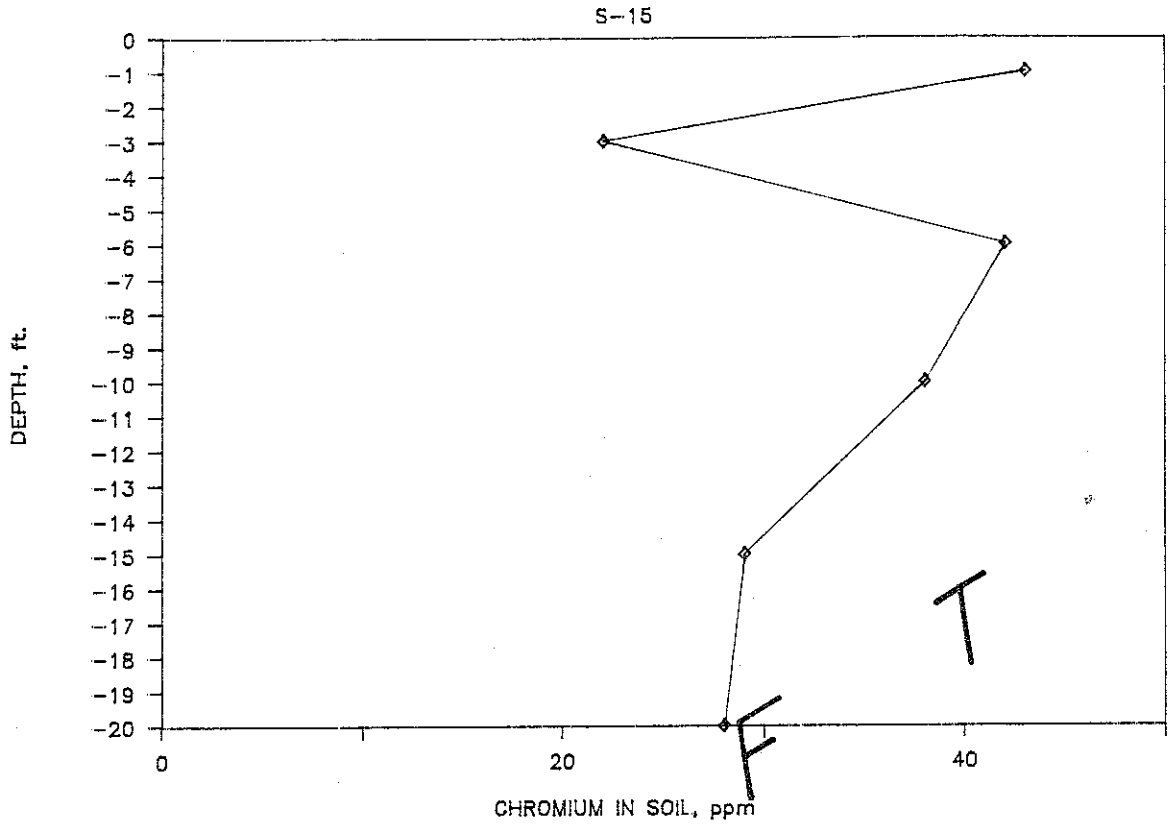

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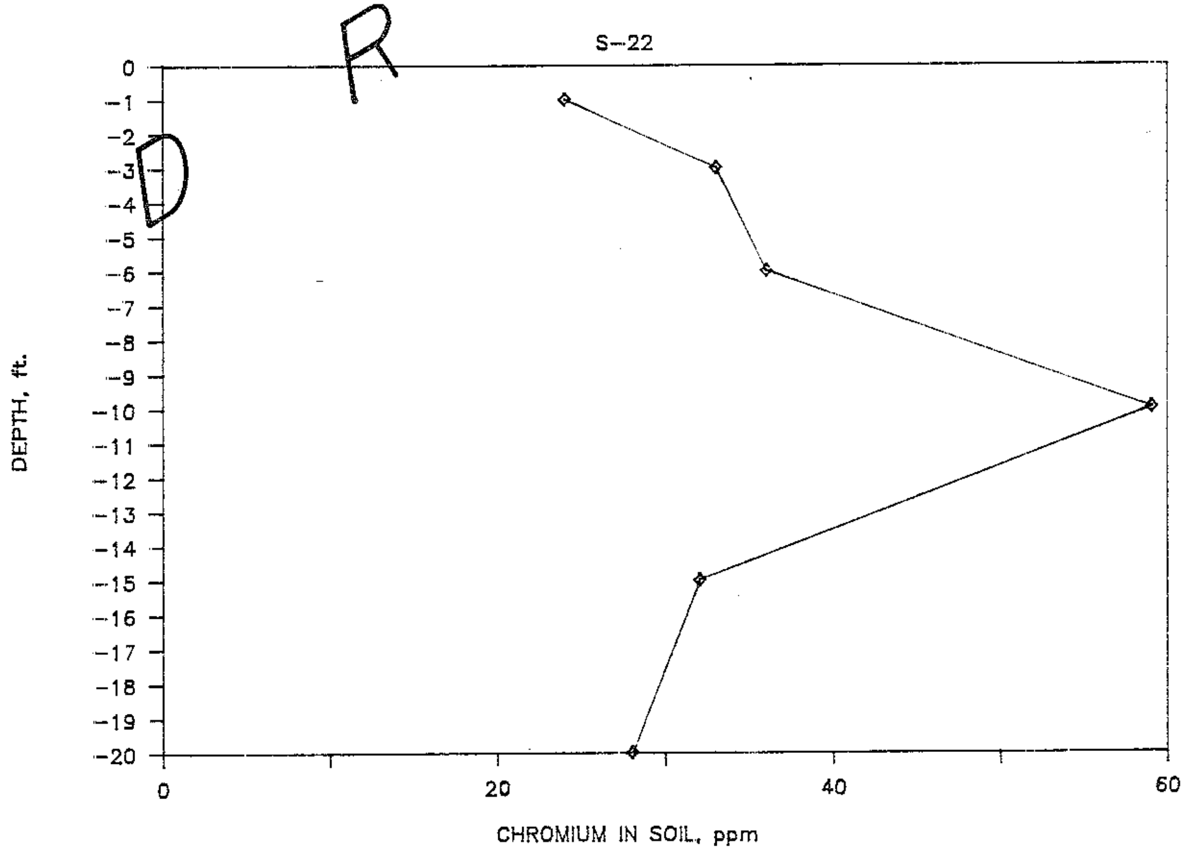

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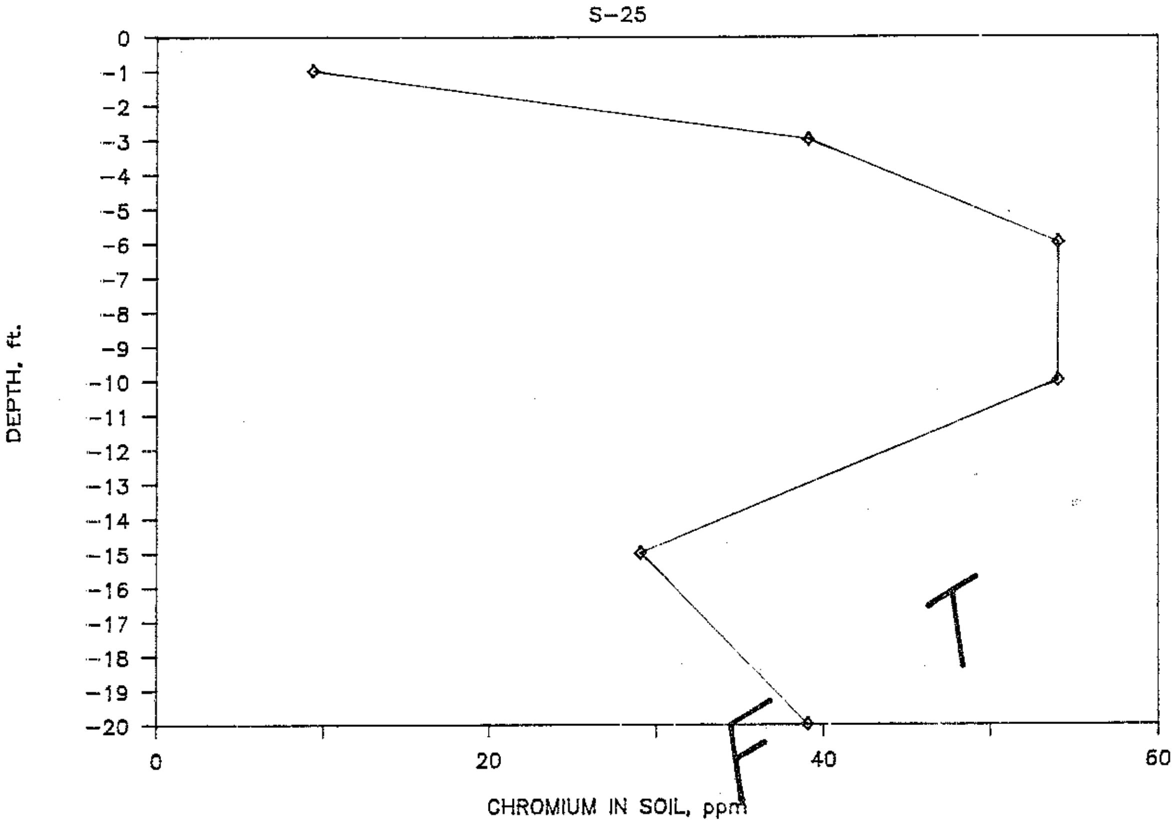

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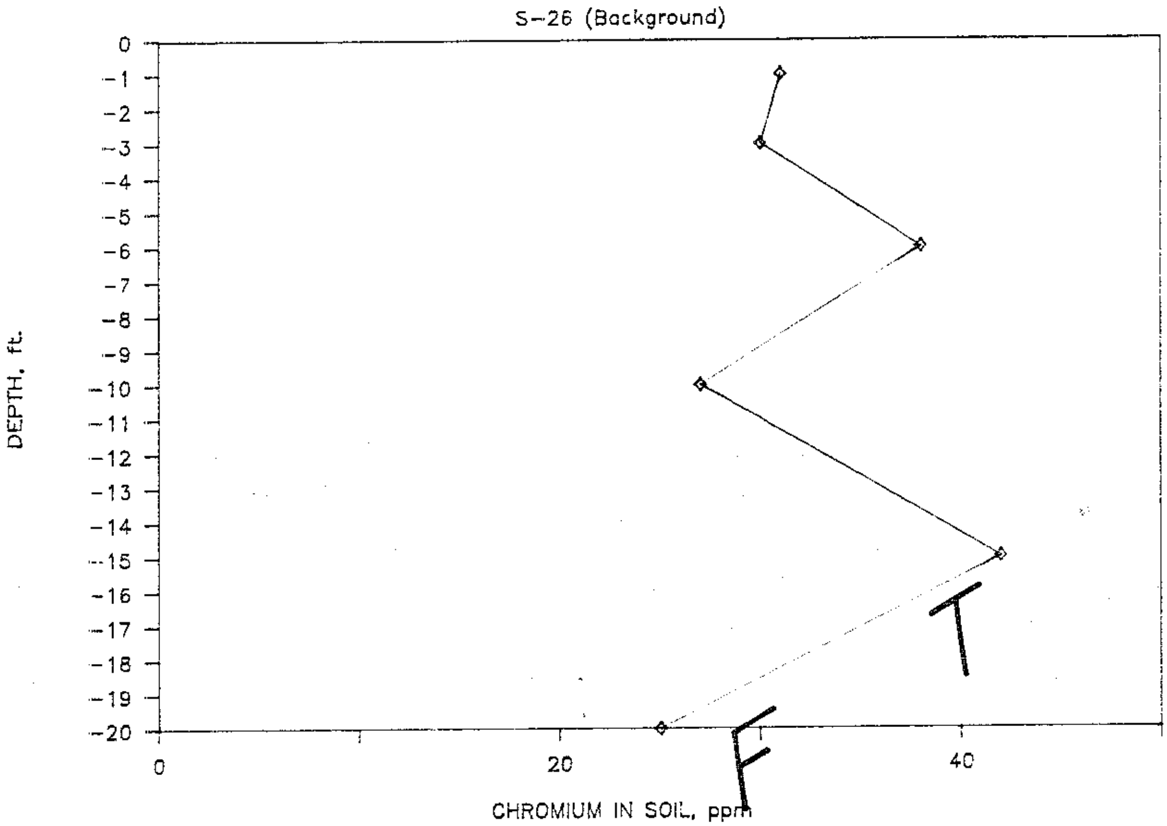

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GEOSYSTEM

Scenario 1

1 *CONTROL INFORMATION*

```
VELOCITY(M/DAY)-------------------------- =     0.4750
LONGITUDINAL DISPERSION COEF.(M*M/DAY)- =     0.4750
TRANSVERSE DISPERSION COEF.(M*M/DAY)--- =     0.0475
HALF LENGTH OF SOURCE (M)-------------- =    15.0000


RADIOACTIVE DECAY CONSTANT(1/DAY)------- =     0.0000
RETARDATION FACTOR---------------------- =     5.0000
SOURCE DECAY FACTOR(1/DAY)-------------- =     0.0063

TOTAL NUMBER OF X POSITIONS------------- =     8
TOTAL NUMBER OF Y POSITIONS------------  =     4
TOTAL NUMBER OF TIME POINTS------------  =     8
```

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 180.0 DAYS

V=0.475 A= 15.0 DL= 0.47 DT= 0.05 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.00000	0.00000	0.00000	0.00000
75.0	0.00000	0.00000	0.00000	0.00000
100.0	0.00000	0.00000	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 270.0 DAYS

V=0.475 A= 15.0 DL= 0.47 DT= 0.05 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.00042	0.00001	0.00000	0.00000
75.0	0.00000	0.00000	0.00000	0.00000
100.0	0.00000	0.00000	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 360.0 DAYS

V=0.475 A= 15.0 DL= 0.47 DT= 0.05 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.02942	0.00071	0.00000	0.00000
75.0	0.00000	0.00000	0.00000	0.00000
100.0	0.00000	0.00000	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 540.0 DAYS

V=0.475 A= 15.0 DL= 0.47 DT= 0.05 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.36881	0.01761	0.00000	0.00000
75.0	0.00991	0.00055	0.00000	0.00000
100.0	0.00000	0.00000	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 720.0 DAYS

V=0.475 A= 15.0 DL= 0.47 DT= 0.05 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.30551	0.01927	0.00000	0.00000
75.0	0.21309	0.01699	0.00000	0.00000
100.0	0.00350	0.00029	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 900.0 DAYS

V=0.475 A= 15.0 DL= 0.47 DT= 0.05 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.11901	0.00823	0.00000	0.00000
75.0	0.35252	0.03452	0.00000	0.00000
100.0	0.10564	0.01129	0.00000	0.00000
125.0	0.00127	0.00014	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1080.0 DAYS

V=0.475 A= 15.0 DL= 0.47 DT= 0.05 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.03932	0.00277	0.00000	0.00000
75.0	0.19743	0.02146	0.00000	0.00000
100.0	0.30991	0.03862	0.00000	0.00000
125.0	0.04831	0.00627	0.00000	0.00000
150.0	0.00047	0.00006	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 1440.Ø DAYS
****

V=Ø.475 A= 15.Ø DL= Ø.47 DT= Ø.Ø5 R= 5.ØØ

ALFA=Ø ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.ØØ4Ø8	Ø.ØØØ29	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.Ø2423	Ø.ØØ277	Ø.ØØØØØ	Ø.ØØØØØ
1ØØ.Ø	Ø.12589	Ø.Ø1822	Ø.ØØØØØ	Ø.ØØØØØ
125.Ø	Ø.29693	Ø.Ø4722	Ø.ØØØØØ	Ø.ØØØØØ
15Ø.Ø	Ø.14Ø62	Ø.Ø2312	Ø.ØØØØØ	Ø.ØØØØØ
175.Ø	Ø.ØØ894	Ø.ØØ149	Ø.ØØØØØ	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØØØ7	Ø.ØØØØ1	Ø.ØØØØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ

Scenario 2

1 *CONTROL INFORMATION*

```
VELOCITY(M/DAY)------------------------ =     Ø.475Ø
LONGITUDINAL DISPERSION COEF.(M*M/DAY)- =     1.42ØØ
TRANSVERSE DISPERSION COEF.(M*M/DAY)--- =     Ø.142Ø
HALF LENGTH OF SOURCE (M)-------------- =    15.ØØØØ


RADIOACTIVE DECAY CONSTANT(1/DAY)------ =     Ø.ØØØØ
RETARDATION FACTOR--------------------- =     5.ØØØØ
SOURCE DECAY FACTOR(1/DAY)------------- =     Ø.ØØ63

TOTAL NUMBER OF X POSITIONS------------ =     8
TOTAL NUMBER OF Y POSITIONS-----------  =     4
TOTAL NUMBER OF TIME POINTS-----------  =     8
```

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 18Ø.Ø DAYS

****

V=Ø.475 A= 15.Ø DL= 1.42 DT= Ø.14 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.ØØØ8Ø	Ø.ØØØØ4	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
1ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
125.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
15Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
175.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 27Ø.Ø DAYS

****

V=Ø.475 A= 15.Ø DL= 1.42 DT= Ø.14 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.Ø2829	Ø.ØØ252	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.ØØØØ5	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
1ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
125.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
15Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
175.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 36Ø.Ø DAYS

****

V=Ø.475 A= 15.Ø DL= 1.42 DT= Ø.14 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.12431	Ø.Ø1465	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.ØØ261	Ø.ØØØ33	Ø.ØØØØØ	Ø.ØØØØØ
1ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
125.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
15Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
175.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ

DRAFT

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 540.0 DAYS
****

V=0.475 A= 15.0 DL= 1.42 DT= 0.14 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.29257	0.04647	0.00000	0.00000
75.0	0.07659	0.01317	0.00000	0.00000
100.0	0.00297	0.00053	0.00000	0.00000
125.0	0.00002	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 720.0 DAYS
****

V=0.475 A= 15.0 DL= 1.42 DT= 0.14 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.23921	0.04463	0.00000	0.00000
75.0	0.21672	0.04420	0.00000	0.00000
100.0	0.04912	0.01037	0.00000	0.00000
125.0	0.00261	0.00056	0.00000	0.00000
150.0	0.00003	0.00001	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 900.0 DAYS
****

V=0.475 A= 15.0 DL= 1.42 DT= 0.14 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.12834	0.02651	0.00001	0.00000
75.0	0.23993	0.05481	0.00002	0.00000
100.0	0.15507	0.03687	0.00002	0.00000
125.0	0.03219	0.00780	0.00001	0.00000
150.0	0.00207	0.00051	0.00000	0.00000
175.0	0.00004	0.00001	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1080.0 DAYS
****

V=0.475 A= 15.0 DL= 1.42 DT= 0.14 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.05600	0.01241	0.00001	0.00000
75.0	0.16648	0.04130	0.00005	0.00000
100.0	0.21379	0.05554	0.00009	0.00000
125.0	0.10929	0.02904	0.00006	0.00000
150.0	0.02138	0.00575	0.00001	0.00000
175.0	0.00157	0.00043	0.00000	0.00000
200.0	0.00004	0.00001	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 1440.Ø DAYS
****

V=Ø.475 A= 15.Ø DL= 1.42 DT= Ø.14 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.ØØ794	Ø.ØØ192	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.Ø4Ø25	Ø.Ø1118	Ø.ØØØØ5	Ø.ØØØØØ
1ØØ.Ø	Ø.11811	Ø.Ø3485	Ø.ØØØ2Ø	Ø.ØØØØØ
125.Ø	Ø.18259	Ø.Ø5553	Ø.ØØØ38	Ø.ØØØØØ
15Ø.Ø	Ø.14143	Ø.Ø4374	Ø.ØØØ33	Ø.ØØØØØ
175.Ø	Ø.Ø5345	Ø.Ø167Ø	Ø.ØØØ13	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØ971	Ø.ØØ3Ø5	Ø.ØØØØ3	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØ3	Ø.ØØØØ1	Ø.ØØØØØ	Ø.ØØØØØ

Scenario 3

1 *CONTROL INFORMATION*

```
VELOCITY(M/DAY)------------------------ =      Ø.475Ø
LONGITUDINAL DISPERSION COEF (M*M/DAY)- =      2.3ØØØ
TRANSVERSE DISPERSION COEF (M*M/DAY)--- =      Ø.23ØØ
HALF LENGTH OF SOURCE (M)-------------- =     15.ØØØØ

RADIOACTIVE DECAY CONSTANT(1/DAY)------ =      Ø.ØØØØ
RETARDATION FACTOR--------------------- =      5.ØØØØ
SOURCE DECAY FACTOR(1/DAY)------------- =      Ø.ØØ63

TOTAL NUMBER OF X POSITIONS------------ =      8
TOTAL NUMBER OF Y POSITIONS----------- =      4
TOTAL NUMBER OF TIME POINTS----------- =      8
```

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 18Ø.Ø DAYS

****

V=Ø.475 A= 15.Ø DL= 2.3Ø DT= Ø.23 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.ØØ719	Ø.ØØØ7Ø	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.ØØØØ1	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
1ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
125.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
15Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
175.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 27Ø.Ø DAYS

****

V=Ø.475 A= 15.Ø DL= 2.3Ø DT= Ø.23 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.Ø6662	Ø.ØØ931	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.ØØ116	Ø.ØØØ17	Ø.ØØØØØ	Ø.ØØØØØ
1ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
125.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
15Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
175.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ

1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 36Ø.Ø DAYS

****

V=Ø.475 A= 15.Ø DL= 2.3Ø DT= Ø.23 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.1643Ø	Ø.Ø28Ø2	Ø.ØØØØØ	Ø.ØØØØØ
75.Ø	Ø.Ø1413	Ø.ØØ257	Ø.ØØØØØ	Ø.ØØØØØ
1ØØ.Ø	Ø.ØØØ2Ø	Ø.ØØØØ4	Ø.ØØØØØ	Ø.ØØØØØ
125.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
15Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
175.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
2ØØ.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ	Ø.ØØØØØ

DRAFT

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 540.0 DAYS

V=0.475 A= 15.0 DL= 2.30 DT= 0.23 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.25719	0.05517	0.00002	0.00000
75.0	0.11125	0.02551	0.00001	0.00000
100.0	0.01433	0.00338	0.00000	0.00000
125.0	0.00054	0.00013	0.00000	0.00000
150.0	0.00001	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 720.0 DAYS

V=0.475 A= 15.0 DL= 2.30 DT= 0.23 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.19987	0.04936	0.00008	0.00000
75.0	0.19757	0.05227	0.00011	0.00000
100.0	0.07824	0.02136	0.00006	0.00000
125.0	0.01240	0.00344	0.00001	0.00000
150.0	0.00078	0.00022	0.00000	0.00000
175.0	0.00002	0.00001	0.00000	0.00000
200.0	0.00000	0.00000	0.00[illegible]	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 900.0 DAYS

V=0.475 A= 15.0 DL= 2.30 DT= 0.23 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.11617	0.03180	0.00014	0.00000
75.0	0.19118	0.05616	0.00032	0.00000
100.0	0.14989	0.04554	0.00031	0.00000
125.0	0.05630	0.01743	0.00013	0.00000
150.0	0.01012	0.00317	0.00003	0.00000
175.0	0.00087	0.00027	0.00000	0.00000
200.0	0.00004	0.00001	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1080.0 DAYS

V=0.475 A= 15.0 DL= 2.30 DT= 0.23 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.05814	0.01729	0.00015	0.00000
75.0	0.13587	0.04340	0.00049	0.00000
100.0	0.16922	0.05600	0.00074	0.00000
125.0	0.11361	0.03836	0.00057	0.00000
150.0	0.04120	0.01409	0.00022	0.00000
175.0	0.00807	0.00278	0.00005	0.00000
200.0	0.00085	0.00030	0.00001	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1440.0 DAYS

V=0.475 A= 15.0 DL= 2.30 DT= 0.23 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.01157	0.00392	0.00009	0.00000
75.0	0.04286	0.01561	0.00042	0.00000
100.0	0.09674	0.03656	0.00114	0.00000
125.0	0.13578	0.05247	0.00180	0.00000
150.0	0.11940	0.04681	0.00171	0.00000
175.0	0.06595	0.02611	0.00100	0.00000
200.0	0.02289	0.00912	0.00036	0.00000
250.0	0.00068	0.00028	0.00001	0.00000

Scenario 4

1 *CONTROL INFORMATION*

VELOCITY(M/DAY)------------------------ = 0.4750
LONGITUDINAL DISPERSION COEF.(M*M/DAY)- = 4.7500
TRANSVERSE DISPERSION COEF.(M*M/DAY)--- = 0.4750
HALF LENGTH OF SOURCE (M)-------------- = 15.0000

RADIOACTIVE DECAY CONSTANT(1/DAY)------ = 0.0000
RETARDATION FACTOR--------------------- = 5.0000
SOURCE DECAY FACTOR(1/DAY)------------- = 0.0063

TOTAL NUMBER OF X POSITIONS------------ = 8
TOTAL NUMBER OF Y POSITIONS----------- = 4
TOTAL NUMBER OF TIME POINTS----------- = 8

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 180.0 DAYS
****

V=0.475 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.04810	0.00839	0.00000	0.00000
75.0	0.00129	0.00024	0.00000	0.00000
100.0	0.00001	0.00000	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 270.0 DAYS
****

V=0.475 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.13678	0.02999	0.00001	0.00000
75.0	0.01774	0.00414	0.00000	0.00000
100.0	0.00070	0.00017	0.00000	0.00000
125.0	0.00001	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 360.0 DAYS
****

V=0.475 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.19637	0.04964	0.00009	0.00000
75.0	0.05738	0.01547	0.00004	0.00000
100.0	0.00680	0.00189	0.00001	0.00000
125.0	0.00033	0.00009	0.00000	0.00000
150.0	0.00001	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 540.0 DAYS

V=0.475 A= 15.0 DL= 4.75 DT= 0 47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.19838	0.06080	0.00063	0.00000
75.0	0.13632	0.04449	0.00058	0.00000
100.0	0.04972	0.01676	0.00025	0.00000
125.0	0.00985	0.00338	0.00006	0.00000
150.0	0.00107	0.00037	0.00001	0.00000
175.0	0.00006	0.00002	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 720.0 DAYS

V=0.475 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.13893	0.04896	0.00127	0.00000
75.0	0.15177	0.05674	0.00176	0.00000
100.0	0.09970	0.03848	0.00134	0.00000
125.0	0.04072	0.01603	0.00061	0.00000
150.0	0.01048	0.00418	0.00017	0.00000
175.0	0.00171	0.00069	0.00003	0.00000
200.0	0.00018	0.00007	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 900.0 DAYS

V=0.475 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.08424	0.03325	0.00156	0.00001
75.0	0.12436	0.05175	0.00280	0.00002
100.0	0.11835	0.05075	0.00302	0.00002
125.0	0.07565	0.03307	0.00210	0.00002
150.0	0.03307	0.01464	0.00098	0.00001
175.0	0.00997	0.00446	0.00031	0.00000
200.0	0.00208	0.00094	0.00007	0.00000
250.0	0.00003	0.00001	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1080.0 DAYS

V=0.475 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.04788	0.02081	0.00150	0.00002
75.0	0.08764	0.03987	0.00320	0.00004
100.0	0.10805	0.05048	0.00437	0.00006
125.0	0.09403	0.04471	0.00409	0.00006
150.0	0.05899	0.02840	0.00271	0.00004
175.0	0.02697	0.01310	0.00129	0.00002
200.0	0.00904	0.00442	0.00045	0.00001
250.0	0.00041	0.00020	0.00002	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1440.0 DAYS

****

V=0.475 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.01446	0.00734	0.00095	0.00003
75.0	0.03530	0.01848	0.00253	0.00009
100.0	0.06123	0.03268	0.00469	0.00017
125.0	0.07962	0.04308	0.00642	0.00025
150.0	0.07961	0.04351	0.00668	0.00027
175.0	0.06203	0.03416	0.00536	0.00022
200.0	0.03796	0.02104	0.00337	0.00014
250.0	0.00702	0.00392	0.00065	0.00003

Scenario 5

1 *CONTROL INFORMATION*

```
VELOCITY(M/DAY)------------------------- =      0.7130
LONGITUDINAL DISPERSION COEF.(M*M/DAY)- =      3.5600
TRANSVERSE DISPERSION COEF.(M*M/DAY)--- =      0.3560
HALF LENGTH OF SOURCE (M)-------------- =     15.0000

RADIOACTIVE DECAY CONSTANT(1/DAY)------ =      0.0000
RETARDATION FACTOR--------------------- =      5.0000
SOURCE DECAY FACTOR(1/DAY)------------- =      0.0063

TOTAL NUMBER OF X POSITIONS------------ =      8
TOTAL NUMBER OF Y POSITIONS-----------  =      4
TOTAL NUMBER OF TIME POINTS-----------  =      8
```

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 180.0 DAYS

****

V=0.713 A= 15.0 DL= 3.56 DT= 0.36 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.07549	0.01072	0.00000	0.00000
75.0	0.00143	0.00022	0.00000	0.00000
100.0	0.00000	0.00000	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 270.0 DAYS

****

V=0.713 A= 15.0 DL= 3.56 DT= 0.36 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.24261	0.04463	0.00000	0.00000
75.0	0.03522	0.00698	0.00000	0.00000
100.0	0.00111	0.00023	0.00000	0.00000
125.0	0.00001	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 360.0 DAYS

****

V=0.713 A= 15.0 DL= 3.56 DT= 0.36 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.32748	0.06976	0.00002	0.00000
75.0	0.13117	0.03032	0.00002	0.00000
100.0	0.01706	0.00408	0.00000	0.00000
125.0	0.00070	0.00017	0.00000	0.00000
150.0	0.00001	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1440.0 DAYS

****

V=0.713 A= 15.0 DL= 3.56 DT= 0.36 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.00213	0.00072	0.00002	0.00000
75.0	0.00747	0.00296	0.00015	0.00000
100.0	0.02178	0.00939	0.00062	0.00001
125.0	0.05092	0.02306	0.00178	0.00002
150.0	0.09298	0.04340	0.00371	0.00005
175.0	0.13030	0.06203	0.00567	0.00008
200.0	0.13857	0.06686	0.00640	0.00010
250.0	0.06666	0.03269	0.00332	0.00006

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 540.0 DAYS
****

V=0.950 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.18427	0.04942	0.00029	0.00000
75.0	0.27962	0.08584	0.00083	0.00000
100.0	0.27356	0.08942	0.00115	0.00000
125.0	0.16126	0.05449	0.00083	0.00000
150.0	0.05510	0.01898	0.00032	0.00000
175.0	0.01068	0.00372	0.00007	0.00000
200.0	0.00116	0.00041	0.00001	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 720.0 DAYS
****

V=0.950 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.06972	0.01992	0.00023	0.00000
75.0	0.14023	0.04708	0.00093	0.00000
100.0	0.21692	0.07901	0.00215	0.00000
125.0	0.24100	0.09180	0.00300	0.00001
150.0	0.18377	0.07187	0.00263	0.00001
175.0	0.09356	0.03720	0.00147	0.00000
200.0	0.03127	0.01257	0.00052	0.00000
250.0	0.00095	0.00039	0.00002	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 900.0 DAYS
****

V=0.950 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.02396	0.00708	0.00011	0.00000
75.0	0.05505	0.01950	0.00058	0.00000
100.0	0.10808	0.04226	0.00177	0.00001
125.0	0.17047	0.07056	0.00364	0.00002
150.0	0.20578	0.08813	0.00516	0.00003
175.0	0.18405	0.08054	0.00512	0.00004
200.0	0.11948	0.05302	0.00356	0.00003
250.0	0.01833	0.00827	0.00059	0.00001

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1080.0 DAYS
****

V=0.950 A= 15.0 DL= 4.75 DT= 0.47 R= 5.00

ALFA=0.0063 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.00793	0.00238	0.00005	0.00000
75.0	0.01946	0.00712	0.00027	0.00000
100.0	0.04355	0.01784	0.00098	0.00001
125.0	0.08447	0.03706	0.00256	0.00003
150.0	0.13554	0.06204	0.00495	0.00006
175.0	0.17362	0.08184	0.00715	0.00010
200.0	0.17327	0.08293	0.00772	0.00012
250.0	0.07691	0.03758	0.00377	0.00006

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1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 1440.Ø DAYS

V=Ø.950 A= 15.Ø DL= 4.75 DT= Ø.47 R= 5.ØØ

ALFA=Ø.ØØ63 LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.ØØØ84	Ø.ØØØ26	Ø.ØØØØ1	Ø.ØØØØØ
75.Ø	Ø.ØØ216	Ø.ØØØ81	Ø.ØØØØ4	Ø.ØØØØØ
1ØØ.Ø	Ø.ØØ541	Ø.ØØ233	Ø.ØØØ17	Ø.ØØØØØ
125.Ø	Ø.Ø1284	Ø.ØØ6Ø3	Ø.ØØØ58	Ø.ØØØØ1
15Ø.Ø	Ø.Ø2787	Ø.Ø1388	Ø.ØØ159	Ø.ØØØØ4
175.Ø	Ø.Ø5349	Ø.Ø2768	Ø.ØØ358	Ø.ØØØ11
2ØØ.Ø	Ø.Ø8822	Ø.Ø4686	Ø.ØØ656	Ø.ØØØ23
25Ø.Ø	Ø.14Ø84	Ø.Ø77Ø9	Ø.Ø1185	Ø.ØØØ47

Scenario 7

1 *CONTROL INFORMATION*

```
VELOCITY(M/DAY)------------------------- =    0.4750
LONGITUDINAL DISPERSION COEF (M*M/DAY)-- =    3.3000
TRANSVERSE DISPERSION COEF (M*M/DAY)---- =    0.2300
HALF LENGTH OF SOURCE (M)--------------- =   15.0000

RADIOACTIVE DECAY CONSTANT(1/DAY)------- =    0.0000
RETARDATION FACTOR---------------------- =    5.0000
SOURCE DECAY FACTOR(1/DAY)-------------- =    0.0000

TOTAL NUMBER OF X POSITIONS------------- =    8
TOTAL NUMBER OF Y POSITIONS------------  =    4
TOTAL NUMBER OF TIME POINTS------------  =    8
```

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 180.0 DAYS

****

V=0.475 A= 15.0 DL= 3.30 DT= 0.23 R= 5.00

ALFA=0.0000 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.02537	0.00233	0.00000	0.00000
75.0	0.00014	0.00001	0.00000	0.00000
100.0	0.00000	0.00000	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 270.0 DAYS

****

V=0.475 A= 15.0 DL= 3.30 DT= 0.23 R= 5.00

ALFA=0.0000 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.13943	0.01812	0.00000	0.00000
75.0	0.00684	0.00099	0.00000	0.00000
100.0	0.00007	0.00001	0.00000	0.00000
125.0	0.00000	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 360.0 DAYS

****

V=0.475 A= 15.0 DL= 3.30 DT= 0.23 R= 5.00

ALFA=0.0000 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.30811	0.04805	0.00000	0.00000
75.0	0.04371	0.00764	0.00000	0.00000
100.0	0.00192	0.00035	0.00000	0.00000
125.0	0.00002	0.00000	0.00000	0.00000
150.0	0.00000	0.00000	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 540.0 DAYS

****

V=0.475 A= 15.0 DL= 3.30 DT= 0.23 R= 5.00

ALFA=0.0000 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.61117	0.11490	0.00002	0.00000
75.0	0.23744	0.05126	0.00002	0.00000
100.0	0.04592	0.01050	0.00000	0.00000
125.0	0.00408	0.00096	0.00000	0.00000
150.0	0.00018	0.00004	0.00000	0.00000
175.0	0.00000	0.00000	0.00000	0.00000
200.0	0.00000	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 720.0 DAYS

****

V=0.475 A= 15.0 DL= 3.30 DT= 0.23 R= 5.00

ALFA=0.0000 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.79060	0.16268	0.00012	0.00000
75.0	0.47873	0.11595	0.00015	0.00000
100.0	0.18595	0.04839	0.00009	0.00000
125.0	0.04243	0.01145	0.00003	0.00000
150.0	0.00541	0.00149	0.00000	0.00000
175.0	0.00038	0.00010	0.00000	0.00000
200.0	0.00001	0.00000	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 900.0 DAYS

****

V=0.475 A= 15.0 DL= 3.30 DT= 0.23 R= 5.00

ALFA=0.0000 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.88096	0.19016	0.00030	0.00000
75.0	0.66477	0.17271	0.00053	0.00000
100.0	0.37693	0.10691	0.00050	0.00000
125.0	0.14705	0.04368	0.00026	0.00000
150.0	0.03727	0.01137	0.00008	0.00000
175.0	0.00593	0.00184	0.00001	0.00000
200.0	0.00058	0.00018	0.00000	0.00000
250.0	0.00000	0.00000	0.00000	0.00000

1 VALUES OF CONCENTATION(C/C0) AT TIME T= 1080.0 DAYS

****

V=0.475 A= 15.0 DL= 3.30 DT= 0.23 R= 5.00

ALFA=0.0000 LAMBDA=0.0000

X	Y= 0.0	Y= 20.0	Y= 40.0	Y= 60.0
50.0	0.92416	0.20473	0.00050	0.00000
75.0	0.78147	0.21215	0.00110	0.00000
100.0	0.55081	0.16580	0.00136	0.00000
125.0	0.29871	0.09520	0.00103	0.00000
150.0	0.11723	0.03863	0.00050	0.00000
175.0	0.03198	0.01076	0.00015	0.00000
200.0	0.00592	0.00202	0.00003	0.00000
250.0	0.00006	0.00002	0.00000	0.00000

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1 VALUES OF CONCENTATION(C/CØ) AT TIME T= 1440.Ø DAYS

V=Ø.475 A= 15.Ø DL= 3.30 DT= Ø.23 R= 5.ØØ

ALFA=Ø.ØØØØ LAMBDA=Ø.ØØØØ

X	Y= Ø.Ø	Y= 2Ø.Ø	Y= 4Ø.Ø	Y= 6Ø.Ø
5Ø.Ø	Ø.95396	Ø.21595	Ø.ØØØ83	Ø.ØØØØØ
75.Ø	Ø.88328	Ø.25Ø57	Ø.ØØ224	Ø.ØØØØØ
1ØØ.Ø	Ø.762Ø4	Ø.24587	Ø.ØØ379	Ø.ØØØØØ
125.Ø	Ø.58246	Ø.2Ø339	Ø.ØØ443	Ø.ØØØØ1
15Ø.Ø	Ø.37327	Ø.13693	Ø.ØØ37Ø	Ø.ØØØØ1
175.Ø	Ø.19149	Ø.Ø7248	Ø.ØØ225	Ø.ØØØØØ
2ØØ.Ø	Ø.Ø76Ø6	Ø.Ø2938	Ø.ØØ1ØØ	Ø.ØØØØØ
25Ø.Ø	Ø.ØØ513	Ø.ØØ2Ø3	Ø.ØØØØ8	Ø.ØØØØØ

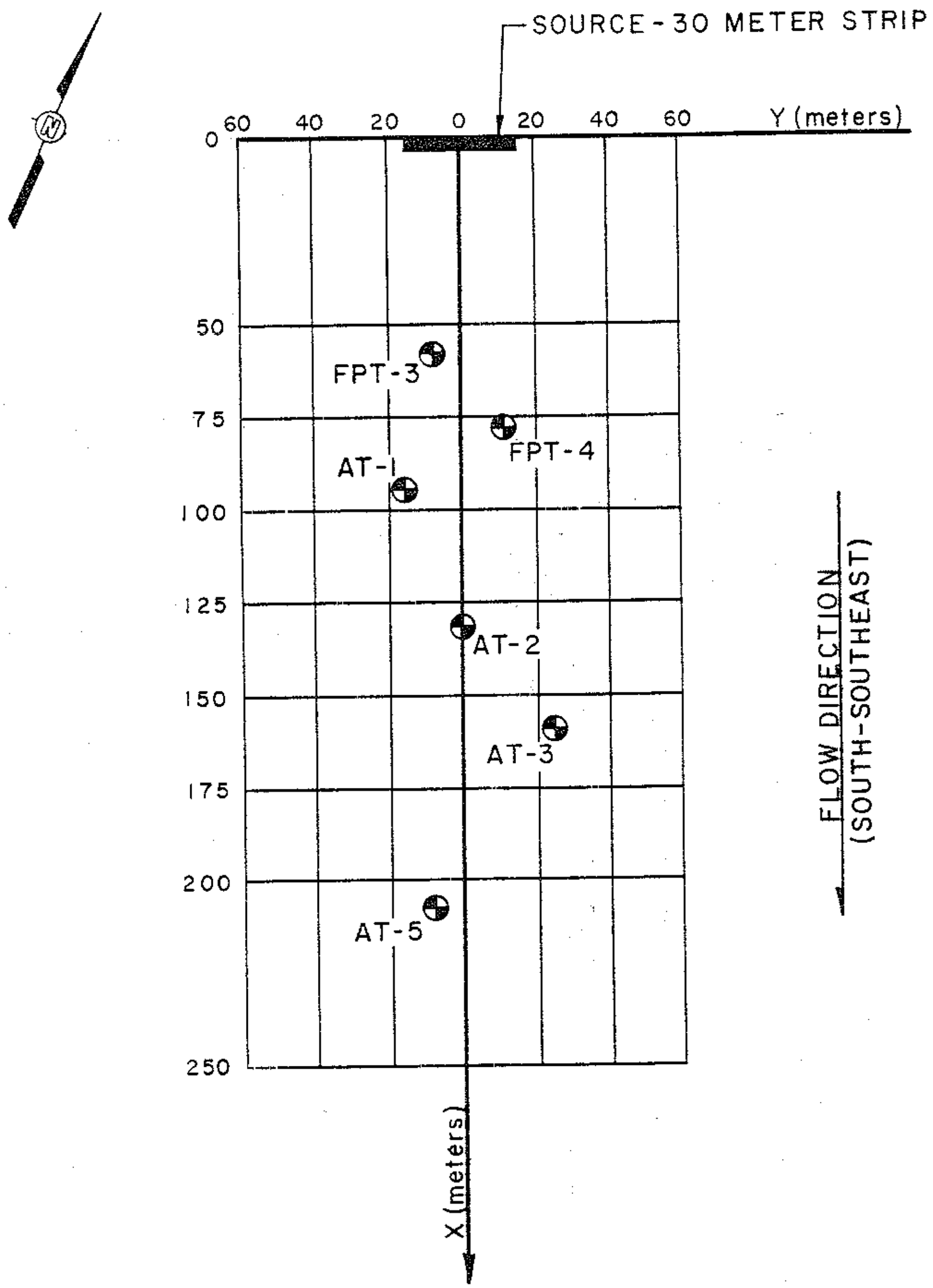

FIGURE E-1

MODEL GRID

COAST WOOD PRESERVING, INC
UKIAH, CALIFORNIA

GEOSYSTEM

DRAWN BY	CHECKED BY	DRAWING NUMBER
SHS 7-31-87	2-3-89	86-113-A4
	APPROVED BY 2-3-89	

APPENDIX E

SIMULATION OF CHROMIUM TRANSPORT
IN OFF-SITE AREAS

D R A F T

GEOSYSTEM

E.5 SENSITIVITY ANALYSIS

To assess the model behavior in an attempt to simulate the observed off-site concentrations, a sensitivity analysis was performed. Factors considered for sensitivity analysis included the porosity and dispersivities. The reason for selecting these two factors was that none of these parameters were measured. Parameters such as hydraulic conductivity, hydraulic gradient, and retardation factor remained constant because measured values were available. For sensitivity analysis, three effective porosities of 0.15, 0.2, and 0.3 were used. The longitudinal dispersivities for sensitivity analysis were 1, 3, 5, and 10. The transverse dispersivities were assumed to be equal to 10 percent of longitudinal dispersivities for each simulation.

The results of the sensitivity analysis are presented in the attached computer outputs. The concentrations of chromium at different grid points, as calculated by the model, are expressed relative to the unit concentration at the source.

The results of the sensitivity analysis show that at the plume centerline (y = o and x = 250m), for a constant porosity, as dispersivity increases, the relative concentration increases. At a constant dispersivity of 5 m, as porosity decreases, the relative concentration increases. Comparing the results of the sensitivity analysis with the observed concentrations, an attempt was made to select the most representative model parameters. The procedure is described below.

The original source concentration has been assumed to be 1.1 mg/l. This concentration represents the chromium concentration measured in Well CWP-8 in December 1984, shortly after the cutoff wall was constructed. The model results for porosity of 0.3 and longitudinal dispersivity of 5 m indicate that after 1,080 days (about 3 years), the relative concentration at a receptor 125 m downgradient of the source would be 0.11361. This

distance corresponds approximately to the location of Well AT-2. The predicted concentration is calculated to be 0.12 mg/l. The most recent chromium concentration in Well AT-2 was 0.05 mg/l on February 25, 1987 (Table B.2, Appendix B). The predicted concentration is, however, on the order of measurements made in late 1986. Model results showed a relative chromium concentration of 0.13587 at a location near Well FPT-3. This indicates that using a source concentration of 1.1 mg/l, the predicted concentration at FPT-3 would be 0.15 mg/l after about 3 years. The measured concentration for that time measured in December 1987 is 0.04 mg/l. Therefore, porosity of 0.3 and longitudinal dispersivity of 5 m appear to be reasonable and conservative for modeling purposes.

E.6 RESULTS

Since all relative concentrations are less than unity, and considering that the highest chromium concentration in any of the off-site wells near the assumed strip source was 0.05 mg/l in Well CWP-8 on February 25, 1987 (Table B.2, Appendix B), all downgradient concentrations should be less than the drinking water standard. Therefore, if the chromium concentration at the source does not increase, the model predictions show that chromium concentration in off-site areas should not exceed 0.05 mg/l. For instance, considering the model results after 1,440 days (approximately 4 years), it may be seen that the relative chromium concentration, along the centerline y = o, at 250 meters from the site is 0.00068. Therefore, the chromium concentration will be equal to 3.4×10^{-5} mg/l or 0.034 ppb. Because of lateral dispersion, as 'y' increases, the calculated relative concentration decreases further. Therefore, the computed concentration at y = o represents the maximum concentration.

If the chromium concentration at the source (Well CWP-8) were to persist for a long period of time, the potential for off-site contamination would exist. To predict possible downgradient

chromium concentrations under such conditions, a simulation was performed by assuming a constant strip source, as shown in Figure E-1. The results, shown in Scenario 7, indicate that at the centerline of the plume, where concentrations are highest, the relative concentration would be 0.00513 at 250 meters from the source. Assuming that the most recent data in Well CWP-8 reflect the strength of the source, the predicted downgradient concentration would be 0.00077 mg/l if the source concentration remains at 0.15 mg/l for four years. An increase in source concentration to 1 mg/l would result in a predicted downgradient concentration of 0.0513 at the same location. It should be noted that given the extraction of ground water from Well CWP-8, increased chromium concentration would not persist for long periods of time.

Application of the model results to other known receptors, such as the Russian River, would result in insignificant chromium concentrations even using the most conservative source strength.

It should be noted that the model is based on a number of assumptions and, thus, the relative concentrations computed by the model should be considered approximate. An attempt was made to use the existing data to calibrate the model for predicting chromium concentrations. However, because of the complexity of the site conditions, such as construction of the slurry wall and the pumping history in Well HL-7, and limitations of the analytical techniques, such calibration was not possible. To include historical water quality data and site modifications to model chromium transport at the CWP site, a numerical model must be used. Such a model would first predict the two-dimensional flow field and compute chromium transport taking into consideration the initial concentrations existing in off-site areas. Such a model could also account for the change in flow regime as a result of slurry wall construction and pumping from Well HL-7. However, the use of such a numerical model for off-site areas is

not warranted because of a lack of sufficient data to verify the model results. Specifically, most, and sometimes all, off-site wells show concentrations of chromium near detection limits. Model calibration and verification becomes exceedingly difficult under such conditions because of a lack of sensitivity and the non-uniqueness of the model results.

TABLE E.1

COMPUTER MODEL TDAST INPUT PARAMETERS

SCENARIO	PORE WATER VELOCITY (m/day)	LONGITUDINAL DISPERSION COEFFICIENT (m^2/day)	TRANSVERSE DISPERSION COEFFICIENT (m^2/day)	HALF-LENGTH OF SOURCE (m)	RADIOACTIVE DECAY CONSTANT (1/day)	RETARDATION FACTOR	SOURCE DECAY FACTOR (1/day)
1	0.475	0.475	0.0475	15	0	5	0.0063
2	0.475	1.42	0.142	15	0	5	0.0063
3	0.475	2.30	0.230	15	0	5	0.0063
4	0.475	4.75	0.475	15	0	5	0.0063
5	0.713	3.56	0.356	15	0	5	0.0063
6	0.950	4.75	0.475	15	0	5	0.0063
7	0.475	3.30	0.230	15	0	5	0

D R A F T

APPENDIX F

OCCURRENCE, INTAKE, AND TOXICITY CHARACTERISTICS OF CHROMIUM AND ARSENIC

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APPENDIX F

OCCURRENCE, INTAKE, AND TOXICITY CHARACTERISTICS OF CHROMIUM AND ARSENIC

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APPENDIX F
OCCURRENCE, INTAKE, AND TOXICITY CHARACTERISTICS OF CHROMIUM AND ARSENIC

F.1 OCCURRENCE OF CHROMIUM IN THE ENVIRONMENT

Chromium occurs naturally in the earth's crust at levels of a few parts per million to 300 ppm. Chromium is also released to the atmosphere by industrial activities, and into the subsurface environment via the disposal of industrial wastewaters and landfilling of solid wastes. Between 1977 and 1980, the mean concentrations of chromium in air in the United States ranged from 0.0052 ug/m^3 (background level) to 0.1568 ug/m^3 (urban annual average). Chromium occurs naturally in surface waters at concentrations ranging from 0.1 to 6 ug/l. A survey of 14 ground water and 69 surface water supplies in 83 United States cities showed chromium levels from less than 5 up to 17 ug/l. In another survey, analyses of 3,834 tap water samples from 35 geographical locations showed that 28 percent of the areas surveyed had chromium levels above the detection limit of 0.1 ug/l. The concentrations of chromium in selected United States soils ranged from less than 1 to 1,000 mg/kg. Several authors have found that chromium concentrations decrease in higher trophic level organisms in aquatic ecosystems (Towill, et al., 1978).

F.2 INTAKE CHARACTERISTICS OF CHROMIUM

Chromium is absorbed through both the respiratory and gastrointestinal tracts (U.S. EPA, 1978). The principal routes of human exposure to chromium are through drinking water, food, and air. Inhalation is both the most predominant route of exposure to chromium compounds in industry and the route most extensively investigated. Concentrations of chromium in water are generally less than 0.05 mg/l; however, approximately 215,000 people in the United States use public water systems with water containing more than 0.05 mg/l. Dietary intake of chromium ranges from 5 to 500

ug/day and averages 100 ug/day. Intake of chromium from the air ranges from 0.03 to 0.3 ug/day and averages 0.1 ug/day. Thus, people drinking high-chromium water (0.05 mg/l) receive about one-half of their chromium intake from food and one-half from drinking water. Those with average-chromium water (0.005 mg/l) receive about 91 percent of their chromium intake from food and 9 percent from water.

In the respiratory tract, water and serum soluble chromates are absorbed into the blood system, whereas insoluble Cr(III) particles and the inert oxides and hydroxides of Cr(III) remain in lung tissue (U.S. EPA, 1978). In the blood stream, chromium compounds are bound by proteins (Gray and Sterling, 1950). It has been shown that ionic Cr(VI) (injected intravenously) passes through the membrane of red blood cells and binds to the globin moiety of hemoglobin. Once inside the erythrocyte, Cr(VI) compounds are rapidly reduced to Cr(III) and are unable to pass through the cell membrane (Aaseth, et al., 1982; Yamaguchi, et al., 1983). In healthy red cells, Cr(III) is partially bound to hemoglobin and partially to small molecular weight substances.

Chromium disappears quickly from the blood and is taken up by other tissues in the body, where it is concentrated much more heavily (by a factor of 10 to 100) than in the blood. Therefore, blood levels of chromium may not be a usable indicator of chromium nutritional status (Mertz, 1969; Mertz and Roginski, 1971).

A wide range of values for chromium content in blood has been reported. Schroeder, et al. (1962) reported chromium levels in serum of 0.52 and 0.17 mg/l, whereas Doisy, et al. (1969, 1971) found a chromium concentration of 2 ug/l in serum. Other chromium values reported have ranged from 0.11 to 55 ug/l in human plasma, and from 5 to 54 ug/l in red blood cells (Underwood, 1971). Imbus,

et al. (1963), working with United States subjects, found blood chromium levels ranging from 13 to 55 ug/l, with a median of 27 ug/l, while Hamilton, et al. (1973), studying subjects from the United Kingdom, reported a blood level of 70 ug/l chromium.

A wide range of values for chromium content in urine has been reported. Hambidge (1971) reported chromium levels in urine of 8.4 ug/l for adults and 5.5 ug/l for children over a 24-hour period. Imbus, et al. (1963) reported median urinary concentrations of chromium for adult males of 3.77 ug/l. Renal excretion is the major pathway of chromium elimination, with more than 80 percent of injected chromium excreted in this manner (Mertz, 1969).

F.3 TOXICITY CHARACTERISTICS OF CHROMIUM

A number of investigations have been performed to evaluate the toxicity of chromium compounds. The most recent and complete reviews are documents prepared by EPA (U.S. EPA, 1984; U.S. EPA, 1986) and by Life Systems, Inc. (October 1985) for the EPA.

F.3.1 Inhalation and Direct Exposure

The production of chromates from chromite and the production of chromate pigments have been associated with occupational respiratory cancer. Workers producing chromate pigments who developed respiratory cancer had an estimated chromium exposure of 0.5 to 1.5 mg/m^3 for 6 to 9 years. To date, chromium compounds have not induced significantly increased incidences of tumors in laboratory animals following exposure by the inhalation and ingestion routes. Neither trivalent nor hexavalent chromium compounds have induced significantly increased incidences of lung tumors by inhalation.

Cr(VI) easily crosses biological membranes and is highly toxic. Cr(VI) levels in air greater than 0.05 mg/m^3 are associated with

high risk of injury to nasal tissues. Levels as low as 0.01 mg/m^3 can produce strong irritation in the nose, even after short exposure. The lethal oral dose of Cr(VI) (single dose basis for humans) is estimated to be 10 mg/kg body weight. The most common manifestation of Cr(VI) poisoning is kidney damage. Repeated exposure to chromium compounds causes dermal sensitization in some workers; such sensitized individuals may react to solutions as dilute as 0.005 percent $K_2Cr_2O_7$. Concentrated Cr(VI) solutions (3 to 10 percent by weight) are corrosive to skin, causing slow-to-heal ulcers.

Local effects on the respiratory system are the primary toxic effects observed in workers exposed to chromium in the atmosphere. Cr(VI), in the form of chromic acid, has been associated for many years with the development of perforations of the nasal septum. The implication of chromic acid as the causative agent results from the common occurrence of this disorder in the chromium-plating industry, where exposure is restricted to this Cr(VI) compound. Other Cr(VI) compounds may also participate in the etiology of perforated nasal septums, since this disorder has been reported in the chromate manufacturing industry, where the predominant exposures are to Cr(III) and the Cr(VI) compounds, sodium chromate and sodium dichromate; however, chromic acid mist may also be present in these plants. Severe irritation of the throat and lower respiratory tract have been associated with Cr(VI) at concentrations as low as 0.12 mg/m^3. Hyper sensitivity may result from dermal or inhalation exposure to either Cr(VI) or Cr(III); however, there is little information available on the levels of exposure necessary to induce an allergic response.

Little information is available on systemic effects of inhalation of chromium compounds, although Pascale, et al. (1952) and Mutti, et al. (1979) reported liver injury in a chromate worker and kidney

injury in a welder exposed to chromium, respectively. Acute exposure of animals using a variety of routes of administration has indicated that both Cr(VI) and Cr(III) compounds can produce kidney and liver damage, although the dose levels employed were relatively high. From the evidence available from both human case reports and animals studies, it can only be speculated whether the kidneys and liver may be target organs following chronic exposure to chromium compounds.

Although inhalation studies of occupational exposure to chromium indicate that exposure to some chromium compounds can result in perforation of the nasal septum, irritation of the respiratory tract, pneumoconiosis, bronchitis, chronic lung congestion, and possible liver and kidney damage (as supported by target organ toxicity in acute animal studies), there are insufficient data available to make a quantitative risk assessment for either chromium as a class or individual chromium compounds from these inhalation studies. The only studies that provide any exposure data are the studies of the occurrence of perforated nasal septums. However, these are of limited and questionable quality. Also, in the study by , inhalation exposure of mice to chromium resulted in marked effects to the respiratory tract. These effects, including hyperplasia and necrosis, were likely to have resulted from the severe local irritation of the cells lining the air ways.

F.3.2 Ingestion

There are only a few instances of human exposure to overtly toxic levels of chromium compounds by ingestion, and these represent

acute exposure to massive doses which provide little information on the safe levels of chromium following chronic exposure. A number of animal studies have been performed in which the chromium compound was administered in the food, water, or by gavage. The acute oral toxicity data indicate that Cr(~~IV~~ VI) is approximately 2 or 3 orders of magnitude more toxic than Cr(III). The difference in valence state may be less relevant following chronic or subchronic ingestion of chromium, since it is suggested that Cr(VI) is reduced to Cr(III) under the acid conditions of the stomach. The determination as to whether Cr(III) or Cr(VI) is more toxic after chronic exposure, however, cannot be made, since none of the studies employed a sufficiently high dose to produce a toxic effect.

The only ingestion study in which an effect was observed was that of Ivankovic and Preussman (1975) in which rats were fed diets containing 2 or 5 percent Cr_2O_3 (Cr^{+3}), 5 days a week, for 90 days. The only observed effect was a reduction in the weight of the liver and spleen in the treated male rats as compared with liver and spleen weights of control animals. Similar results were observed in female rats maintained on the same diet. Neither organ showed macroscopic or microscopic abnormalities, and the authors concluded that these changes were not toxicologically important. In a larger 2-year study using the same experimental procedure and 60 animals of each sex per group, Ivankovic and Preussman (1975) did not mention any treatment-related changes in organ weight, although it was mentioned that no signs of chronic toxicity were observed.

F.3.3 Other Administered Routes

There is some positive evidence that chromium, particularly some hexavalent chromium compounds, is carcinogenic following subcutaneous injection or intrabronchial, intrapleural, intramuscular, or intratracheal implantation; however, implantation

site tumors have only consistently been demonstrated using intramuscular implantation. Of all the chromium salts, calcium chromate is the only one that has been consistently found to be carcinogenic in rats by several routes. Calcium chromate, strontium chromate, zinc chromate, sodium dichromate, lead chromate, lead chromate oxide, and sintered chromium trioxide have produced local sarcomas or lung tumors in rats at the site of application. although the studies available indicate that metallic chromium powder and trivalent chromium compounds are not carcinogenic, these compounds have been studied less extensively than hexavalent chromium compounds. The relevance of studies using intramuscular implantation to human risk following inhalation or oral exposure to chromium compounds is not clear; however, these animal studies may indicate that some hexavalent chromium compounds are likely to be the etiologic agent in human chromium-related cancer.

F.3.4 Reproductive Effects

While chromium compounds have been shown to cause developmental toxicity in experimental animals, reproductive effects (e.g., fetal malformation) were observed only where maternal toxicity was also present. Because of the unnatural routes of exposure in these studies (e.g., intravenous and intraperitoneal injection), the relevance of these developmental effects to environmental exposures is very uncertain.

Chromium has adversely affected fetal development and male reproduction in experimental animals. Hamsters, administered chromium trioxide intravenously on day 8 of gestation, had an increased incidence of cleft palates in the young when examined on day 15 of gestation. The malformations were strain-specific and associated with maternal toxicity. Studies on mice indicated that while some skeletal effects were present, increased incidence of

cleft palate or fetal death were not observed. While several of the studies reported fetal malformations only where maternal toxicity was also present, not all studies reported data on maternal effects. Therefore, definitive conclusions concerning the correlation, if any, between fetal and maternal effects cannot be made at this time.

Other reproductive effects of chromium include testicular degeneration in rabbits receiving 2 mg/kg/day for 6 weeks of either Cr(III) or Cr(VI) compounds by intraperitoneal injection. The Cr(III) compound produced more severe effects in this study than did the Cr(VI) compound (Behari, et al., 1978).

F.3.5 Acute Toxicity

Acute toxicity studies indicate that the LC_{50} for Cr(III) administered intravenously to rats is 10 mg/kg. Many mammalian and microbial studies indicate that Cr(VI) compounds are mutagenic. Acute chromium poisoning is rare in humans. Ingestion of 0.5 to 1.5 g of potassium dichromate can be fatal, causing liver and kidney damage as well as thrombocytopenia and internal hemorrhage.

Acute toxicity values for chromium(VI) are available for freshwater animal species in 27 genera and range from 23.07 ug/l for a cladoceran to 1,870,000 ug/l for a stonefly. These species include a wide variety of animals that perform a wide spectrum of ecological functions. All five tested species of daphnids are especially sensitive. The few data that are available indicate that the acute toxicity of chromium(VI) decreases as hardness and pH increase.

The acute toxicity of chromium(VI) to 23 saltwater vertebrate and invertebrate species ranges from 2,000 ug/l for a polychaete worm and a mysid to 105,000 ug/l for the mud snail. The chronic values

for a polychaete range from less than 13 to 36.74 ug/l, whereas that for a mysid is 132 ug/l. The acute-chronic ratios range from 15.38 to more than 238.5. Toxicity to macroalgae was reported at 1,000 and 5,000 ug/l. Bioconcentration factors for chromium(VI) range from 125 to 236 for bivalve molluscs and polychaetes.

Acute values for chromium(III) are available for 20 freshwater animal species in 18 genera ranging form 2,221 ug/l for a mayfly to 71,060 ug/l for caddisfly. Hardness has a significant influence on toxicity, with chromium(III) being more toxic in soft water.

F.3.6 Chronic Toxicity

Chronic ingestion of water containing 1 mg/l of Cr(VI) over a 3-year period did not produce any adverse health effects in a Long Island family which obtained drinking water from a private well. It should be noted that the degree of medical follow-up of this family, as reported in the literature, was limited to physical examinations.

Subchronic and chronic exposure to Cr(VI) in the form of chromic acid can cause contact dermatitis and ulceration of the skin in humans. Chronic inhalation of dust or air containing Cr(VI) or Cr(III) can cause respiratory effects including perforated or ulcerated nasal septa and decreased spirometric values. Recent studies have suggested that inhalation of Cr(III) compounds does not pose a significant carcinogenic risk to humans. However, an association between prolonged inhalation of Cr(VI) compounds and the development of cancer of the respiratory tract has been suggested by epidemiological studies.

The chronic value for both rainbow trout and brook trout is 264.6 ug/l, which is much lower than the chronic value of 1,987 ug/l for the fathead minnow. The acute-chronic ratios for

these three fishes range form 18.55 to 260.8. In all three chronic tests, a temporary reduction in growth occurred at low concentrations. Six chronic tests with five species of daphnids gave chronic values that range from less than 2.5 to 40 ug/l and the acute-chronic ratios range from 1.130 to more than 9.680. Except for the fathead minnow, all the chronic tests were conducted in soft water. Green algae are quite sensitive to chromium(VI). The bioconcentration factor obtained with rainbow trout is less than 3. Growth of chinook salmon was reduced at a measured concentration of 16 ug/l.

A life-cycle test with *Daphnia magna* in soft water gave a chronic value of 66 ug/l. In a comparable test in hard water the lowest test concentration of 44 ug/l inhibited reproduction of *Daphnia magna*, but this effect may have resulted from ingested precipitated chromium. In a life-cycle test with the fathead minnow in hard water, the chronic value was 1,025 ug/l. Toxicity data are available for only two freshwater plant species. A concentration of 9,900 ug/l inhibited growth of roots of Eurasian watermilfoil. A freshwater green alga was affected by a concentration of 397 ug/l in soft water. No bioconcentration factor has been measured for chromium(III) with freshwater organisms.

Only two acute values are available for chromium(III) in saltwater; 10,300 ug/l for the eastern oyster and 31,500 ug/l for the mummichog. In a chronic test, effects were not observed on a polychaete worm at 50,400 ug/l at a pH of 7.9, but acute lethality occurred at a pH of 4.5. Bioconcentration factors for saltwater organisms and chromium(III) range from 86 to 153, similar to the bioconcentration factors for chromium(VI) and saltwater species.

F.3.7 Aquatic Toxicity of Chromium

Based on Quality Criteria for Water 1986 (U.S. EPA, May 1986), the aquatic toxicity of Cr(VI) and Cr(III) is summarized below:

- o Acute toxicity values for Cr(VI) vary from 23.07 ug/l for a cladoceran to 1,870,000 ug/l for a stonefly, which are fresh water species.
- o The chronic value for rainbow trout and brook trout is 264.6 ug/l, which is less than the chronic value of 1,987 ug/l for the fathead minnow. Growth of chinook salmon was reduced at a measured concentration of 16 ug/l.
- o Acute toxicity of Cr(VI) to salt water vertebrate and invertebrate species ranges from 2,000 ug/l to 105,000 ug/l. The chronic values are much less, ranging from less than 13 to 132.
- o The corresponding concentrations for Cr(III) are higher than those cited for Cr(VI).
- o Acute toxicity of Cr(VI) decreases as hardness and pH increase.

According to EPA, except possibly where a locally important species is very sensitive, fresh water aquatic organisms should not be affected unacceptably if the 4-day average concentration of Cr(VI) does not exceed 11 ug/l more than once in every three years, on the average, and the 1-hour average concentration does not exceed 16 ug/l more than once every three years, on the average. (U.S. EPA, May 1986)

F.4 TOXICITY CHARACTERISTICS OF ARSENIC

The information presented in this section was provided by DHS. According to DHS, this information was obtained from the Agency for Toxic Substances and Disease Registry (U.S. Public Health Service, November 1987) and DHS Air Unit Hazard Evaluation Section (November 1987).

F.4.1 Arsenic Occurrence in Environment

Arsenic occurs naturally in the earth's crust at levels of a few parts per million. Arsenic is isolated commercially as a byproduct during the refining of other metals. Arsenic is released to the atmosphere in large amounts during industrial activities and has resulted in significant local air and soil pollution. The contamination of drinking water is due to naturally-occurring arsenic. The U.S. Geological Survey has found levels of arsenic in surface waters up to approximately 250,000 ug/l; however, the majority of surface and ground waters contain less than 10 ug/l. EPA estimates that most ground and surface water systems contain less than 5 ug/l of arsenic.

F.4.2 Intake Characteristics of Arsenic

Soluble inorganic arsenic salts are well absorbed (70 percent to 98 percent) from the gastrointestinal tract of humans (Coulson, et al., 1935; Bettley and O'Shea, 1975) and animals (Coulson, et al., 1935; Charbonneau, et al., 1978). Insoluble salts are poorly absorbed (Mappes, 1977). Following the ingestion of 8.25 mg of arsenic (as $KAsO_2$ solution) in three doses at eight-hour intervals, human subjects had peak blood levels of arsenic within 24 hours, and absorption was 97 percent to 98 percent complete (Bettley and O'Shea, 1975). Analysis of human tissues at autopsy indicates that arsenic distributes throughout the body and accumulates with time in nails, hair, bone, and skin. Average levels (ppm net weight) were 0.89 in nails; 0.18 in hair; 0.07 to 0.12 in bone and teeth; 0.06 in skin; 0.04 to 0.05 in heart, liver, kidney and lung; and 0.03 in brain (Kadowaki, 1960). In animals dosed with either As^{+3} or As^{+5}, arsenic initially distributes in soft tissues (liver, kidney, lung, spleen, skin, brain) but is cleared quickly from these except for skin and brain (Hunter, et al., 1942; Ducoff, et al., 1948; Crema, 1955; Ariyoshi and Ikeda, 1974; Cikrt and Bencko, 1974; Sabbioni, et al., 1979).

Inorganic arsenic compounds undergo methylation in mammalian species to produce monomethyl and dimethyl arsenic. Buchet, et al. (1981) administered 500 ug of arsenite to human volunteers, and observed that 25 percent was excreted in urine as inorganic arsenic, 25 percent as monomethylarsenic acid, and 50 percent as the dimethyl form. In humans ingesting arsenic-rich wine, about 80 percent of the arsenic ingested (50 ug As^{+3} and 13 ug As^{+5}) was excreted in urine in 61 hours. Of this, 63 percent was dimethyl-arsenic acid, 18 percent was monomethylarsenic acid, and about 9 percent each was inorganic As^{+3} and As^{+5} (Crecelius, 1977). Reduction of administered As^{+5} to As^{+3} has been demonstrated in rats, mice and rabbits (Rowland and Davies, 1982; Vahter and Envall, 1983), but *in vivo* reduction has not been well documented in humans. Excretion of arsenic is primarily via the urine, initially in the same form as the ingested dose and later as the methylated derivatives (Crecelius, 1977). The rate of clearance depends somewhat on valence and dose, but typically 50 to 90 percent is excreted by humans within two to four days (Braman and Foreback, 1973; Crecelius, 1977). In contrast to humans, arsenic is retained in red blood cells of the rat, with a half-time of 60 to 90 days (Lanz, et al., 1950). For this reason, the rat is not an appropriate model for assessing arsenic toxicity in humans.

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F.4.3 Toxicity Characteristics of Arsenic

The toxicity of arsenic depends upon its chemical form and the route and duration of exposure. In general, arsenites (As^{+3}) are more toxic than arsenates (As^{+5}), soluble compounds are more toxic than insoluble compounds, and inorganic compounds are more toxic than organic derivatives. Short-term effects of arsenic poisoning are similar in humans and animals. With oral exposure, symptoms include muscular cramps, facial edema, gastrointestinal damage,

vomiting, diarrhea and general vascular collapse (U.S. EPA, 1984a). Long-term exposure produces effects similar to those observed following short-term exposure, along with signs of injury to the hematopoietic, renal and nervous systems. In humans, chronic exposure to arsenic is associated with a characteristic pattern of skin lesions. For many years, Fowler's solution (As_2O_3 dissolved in potassium bicarbonate) was used as a medicinal. As described by Holland (1904), a patient was usually given five drops (about 9 mg As_2O_3 or 6.8 mg As^{+3}) three times a day. The dose was increased one drop per day until the eyelids puffed and the bowels moved too freely. Most people tolerated the dose of 6.8 mg As^{+3}/day with no adverse effects.

Accidental exposure of humans via ingestion of arsenic-contaminated foods is another source of short-term data in humans. Mizuta, et al. (1956) described an episode of acute arsenic poisoning in Japan caused by arsenic-tainted soy sauce. Exposure was estimated to be about 3 mg/day for two to three weeks, and 417 cases of illness attributed to the arsenic were reported. Symptoms included catarrh and edema of the face and eyelids, along with signs of mild hematological, hepatic, gastrointestinal and neurological effects. Hamamoto (1955) described an incident in Japan where 130 deaths were reported among 12,000 infants exposed to arsenic-contaminated milk. The estimated dose of arsenic in this case was about 3.5 mg/day for about 33 days. Vallee, et al. (1960) estimated the fatal dose for arsenic trioxide for humans to be 70 to 180 mg, but noted that toxicity could result from much smaller quantities.

Silver and Wainman (1952) described a patient who ingested 3.3 to 6.7 mg As^{+3} (as Fowler's solution) daily for 28 months. Signs of arsenic toxicity (increased freckling and darkening of the nipples along with gastrointestinal distress) first occurred after about 13 months. Neurological symptoms (paresthesia and weakness)

occurred after two years. Zaldivar (1974) reported the incidence of chronic arsenic poisoning in Antofagasta, Chile, where water supplies contained arsenic at about 0.58 mg/l. Poisoning was diagnosed on the basis of weight loss, diarrhea, debility, anorexia, bronchitis and skin disorders. The incidence of arsenic-induced toxicity was 146/100,000 in males and 168/100,000 in females. A majority of cases occurred in children (aged 0 to 10 years), with progressively fewer cases in each older age bracket. Installation of a water treatment plant reduced arsenic levels to 0.08 mg/l and dramatically decreased the incidence of arsenic-induced toxicity.

One of the most characteristic effects of chronic arsenic exposure in humans is a pattern of skin disorders, beginning with hyperpigmentation and keratosis, developing in some cases into squamous cell or basal cell carcinoma. These effects have not been consistently produced in laboratory animals. Sommers and McManus (1953) reported 57 cases of multiple skin cancers in humans. Fifteen of the patients had used Fowler's solution, seven had been treated with arsenic, two had known exposure to arsenical sprays and four had possible exposure to sprays. In three, the (presumed) means of arsenic exposure was unknown. Arsenical cancer was diagnosed on the basis of multiple keratoses of palms and soles. A variety of internal cancers (not likely to have arisen by metastasis from the skin cancers) was observed in ten (37 percent) of the patients. The time between arsenic exposure and development of cancer in these patients ranged from 13 to 50 years, with a mean value of 24 years. No precise estimate of exposure levels was provided, but some of the patients took Fowler's solution in "small" doses for only a few months. Fierz (1965) examined 262 patients who had received long courses of medicinal arsenic 6 to 25 years previously and found keratoses in 40 percent and typical skin cancer in 8 percent. There was evidence of a dose

relationship for both keratoses and skin cancer. Patients who had received more than 400 ml of Fowler's solution (4 g of arsenic trioxide) had an incidence of hyperkeratoses of greater than 50 percent, but as little as 60 ml (600 mg of arsenic trioxide) had resulted in keratotic changes in one patient, and only 75 ml (750 mg of arsenic trioxide) had been consumed by one patient with skin cancer. The shortest time to cancerous change was six years, with an average of 14 years.

There have been a number of epidemiologic studies of the relationship between arsenic in drinking water and skin cancer. Tseng, et al. (1968) reported a high prevalence of skin cancer (10.6 percent) in a study population of 40,400 individuals in an area of Taiwan where drinking water was contaminated with 0.4 to 0.6 mg/l of arsenic. A number of epidemiological studies in the United States have failed to detect an association between elevated arsenic levels in drinking water and skin cancer. Goldsmith, et al. (1972) evaluated the effects of well water containing arsenic at 0.1 to 1.4 mg/l on the health of 98 people in Lassen County, California. Data were collected by questionnaire. No arsenic-related illnesses were detected. Morton, et al. (1976) performed a retrospective analysis of skin cancer incidence in Lane County, Oregon, where arsenic levels in water ranged form 0 to 2.15 mg/l. In 3,691 cases of nonmelanoma skin cancer, no significant association with arsenic levels in water was detected. Harrington, et al. (1978) found no signs of arsenic-induced toxicity in 211 individuals in Fairbanks, Alaska, ingesting water containing arsenic at 0.001 to 2.45 mg/l. Southwick, et al. (1981) found signs of arsenic toxicity in 12 of 249 individuals in West Millard County, Utah, where arsenic concentrations ranged from 0.05 to 0.75 mg/l, but no association was noted between arsenic dose and skin lesions. Several studies suggest that low levels of arsenic

may be beneficial to animals, but a beneficial role in humans has not been established.

The International Agency for Research on Cancer (IARC) has reviewed the evidence regarding the carcinogenic potential of arsenic, and has concluded that arsenic is a Group 1 compound (sufficient evidence for carcinogenicity in humans) (WHO, 1982). Applying the criteria described in EPA's proposed guidelines for assessment of carcinogenic risk (U.S. EPA, 1984b), arsenic may be classified in Group A: Human Carcinogen. This category includes agents for which there is sufficient evidence to support the casual association between exposure to the agents and cancer. Only one study (Tseng, et al., 1968) provides sufficient data to permit a quantitative assessment of cancer risk due to arsenic exposure. Assuming consumption of two liters of water/day plus an average of 6.5 g/day fish and shellfish by a 70-kg adult over a 70-year lifetime, U.S. EPA (1980) calculated that drinking water concentrations of 22, 2.2, and 0.2 g/l corresponded to risk levels of 10^{-5}, 10^{-6}, and 10^{-7}, respectively.

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CARCINOGENICITY OF SODIUM DICHROMATE AND CHROMIUM (VI/III) OXIDE AEROSOLS INHALED BY MALE WISTAR RATS*

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SUMMARY

In inhalation chambers, male Wistar rats of the strain TNO-W74 were continuously exposed to submicron aerosols of sodium dichromate and to a pyrolyzed Cr(VI)/Cr(III) (3:2) oxide mixture. The sodium dichromate ($Na_2Cr_2O_7$) aerosol had the chromium concentrations of 25, 50 and 100 $\mu g/m^3$, the chromium oxide mixture (Cr_5O_{12}) had the chromium concentration of 100 $\mu g/m^3$. After 18 months of inhalation the rats were held under conventional conditions for a further year. The experimental groups consisted of 20 rats and the control group of 40 rats.

More than 90% of the rats in each group reached 2 years. At the end of the study the mortality rates amounted to 35%, 45% and 25% in the 3 sodium dichromate aerosol groups, respectively, and 50% in the chromium oxide mixture aerosol group, which was not significantly different from that of the controls (42.5%), living under the same conditions in filtered fresh air.

In all sodium dichromate exposed groups significant effects were neither found clinically nor from hematology and clinical chemistry compared to the controls. In the chromium oxide mixture group, however, there was a number of significant findings. Elevated white and red blood cell counts and serum cholesterol as well as decreased serum total immunoglobulin levels at different stages of the study were observed together with few local lung effects determined histopathologically in this group. We assume that these effects are mainly due to the increased chromium lung burden of the rats.

At the end of the study the lung chromium retention was about 10 times higher for the rats exposed to chromium oxide versus sodium dichromate

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at an aerosol Cr-concentration of 100 $\mu g/m^3$, while the kidney chromium retention was measured to be nearly equal in both groups.

Three primary lung tumors (2 adenomas and 1 adenocarcinoma) and 1 malign tumor of the pharynx were found at the highest Cr-concentration (100 $\mu g/m^3$) of the sodium dichromate aerosol, 1 primary adenoma of the lung was in the chromium oxide mixture group exposed also to a Cr-concentration of 100 $\mu g/m^3$. No primary lung tumors were observed in the other experimental and control groups. These results indicate a weak carcinogenicity at 100 $\mu g/m^3$ for the rats continuously exposed to submicron $Na_2Cr_2O_7$ and Cr_5O_{12} aerosols. Thus, there may be a small carcinogenic risk from occupational relevant chromium air levels. However, results have to be confirmed with larger animal populations.

Key words: Sodium dichromate; Chromium (VI)/(III) oxide mixture; Aerosol generation; Inhalation; Rat; Subclinical toxicity; Primary lung tumors

INTRODUCTION

Several publications were concerned with environmental chromium emitted from anthropogene sources, e.g. ferrochromium and chemical industries, combustions of fossil fuels and the incinerations of municipal refuse. The health risks from chromium in the ambient air, however, are not really known, especially the risk of the carcinogens. In order to minimize the hazard for the general public it is recommended to limit the chromium level to 50 ng/m^3 in the ambient air [1], but no excess tumor rates were found for populations living in areas with a higher chromium pollution [2].

Hexavalent and probably not trivalent chromium may be associated with occupational lung cancer risk [3–7]. Among the employees in highly polluted chromate-producing industries an increase of lung cancer incidences up to 29 times was described [8]. But meanwhile occupational hygiene and new technological measures may have minimized the air concentrations and thus the carcinogenic risk of chromium [9]. The change of manufacture in chromate production has also changed the exposure from the slightly soluble Cr(VI) compounds — evaluated to be carcinogenic — to aqueous soluble alkali chromates [10]. However, with regard to the long latent period for chromium(VI)-induced lung tumors it may be too early to evaluate the differences in the potential risk of easily water soluble versus slightly soluble chromium compounds. The occurrence of lung cancers also in chrome pigment workers [4] confirms the opinion that relatively water insoluble compounds are carcinogenic. However, there are also observations in the chrome-plating and alkali chromate-producing industries [11–14] that suggest a carcinogenic risk from the soluble form, too.

Up to now there were only limited long-term inhalation studies, which did not contribute to answer the question of the chromate carcinogenicity.

TABLE I

NOMINAL AND MEASURED TOTAL CHROMIUM AND CHROMIUM(VI) CONCENTRATIONS (MEANS ± S.D.) OF THE CHROMIUM AEROSOLS USED FOR INHALATION

Compound	Nominal Cr-concentrations ($\mu g/m^3$)	Measured total chromium ($\mu g/m^3$)	Measured chromium(VI) ($\mu g/m^3$)	n
$Na_2Cr_2O_7$	25.0	—	25.5 ± 2.5	99
	50.0	—	50.4 ± 5.7	99
	100.0	—	102.4 ± 8.3	99
Cr_5O_{12}	100.0	100.8 ± 10.2	63.3 ± 7.7	152

specific pathogen free from F. Winkelmann GmbH, Borchen, F.R.G. Twenty animals per experimental group and inhalation chamber were continuously exposed for 18 months, 22—23 h/day, weekends included, to the chromium aerosols with the concentrations given in Table I. In addition 40 control rats were kept under identical conditions breathing filtered room air. There was an artificial 12 h day/night cycle. Drinking water was given ad libitum, new uncontaminated food (Ssniff® standard diet) was offered during the night hours only. After the termination of the 18-month exposure period, all animals were housed singly in macrolon cages under conventional conditions for a further 12 months.

Clinical examinations

Cage-side observations were performed twice a day for signs of toxicity, time of death and appearance of suspected tumors. For the first half year of exposure at each month and thereafter in 3-month intervals the individual body weights and the food and water consumptions of the experimental and control groups were determined. Blood and urine were collected from identical rats per group at the same time intervals. The determination of the hematocrit, the hemoglobin levels, the red blood cell (RBC) and total white blood cell (WBC) counts were performed with EDTA blood by the Digicell 3100 counting system (Contraves, Zürich, Switzerland). Additional differential white blood cell counts were performed by light microscopical examination of slides stained according to May-Grünwald & Giemsa. Serum enzymes (alanine aminotransferase (GPT) and alkaline phosphatase (AP)) and serum contents of total cholesterol, phospholipids, triglycerides and urea were measured with reagent sets from La Roche Diagnostica (Basel, Switzerland) using a COBAS BIO centrifugal analyzer (La Roche). Total serum immunoglobulins were measured photometrically by a turbidimetric method using canine antirat immunoglobulin (DAKO-Z-147, Dakopatts GmbH, Hamburg, F.R.G.) with rat immunoglobulin (Miles Lab., Frankfurt, F.R.G.) in reference. Centrifugated urines (750 g for 5 min, Minifuge GL, Heraeus Christ, Osterode, F.R.G.) were used for the determination of

protein (21). The urinary creatinine contents were measured by a modified Jaffé reaction [22].

Pathological examinations

Dead or dying animals were autopsied as soon as possible after they were detected. The rats surviving 30 months after the begining of the experiment were killed by exsanguination under pentobarbital anesthesia for histopathological examination. Except for one rat in the group exposed to 100 $\mu g/m^3$ as $Na_2Cr_2O_7$ all animals were evaluated histopathologically; this rat was lost due to cannibalism. After gross necropsy the tissue weights of the lungs, livers, kidneys, adrenals, spleens and testes and all suspected tumors were determined. All tissues of the rats were then fixed in 10% buffered formalin. The histopathological examinations were performed light microscopically on Paraplast sections (3—5 μm) stained with H & E reaction.

Chromium in lung and kidneys

A 0.2-g portion (wet wt) of the lungs and kidneys of surviving rats was digested with 5 ml nitric acid (65% Suprapur, E. Merck, Darmstadt, F.R.G.) under pressure at 170°C [23]. After evaporation of the nitric acid the residues were diluted with 0.01 N HNO_3 to determine the chromium contents using a Perkin Elmer model 420 (Überlingen, F.R.G.) atomic absorption spectrometer with deuterium background correction, the HGA 500 graphite furnice (Perkin Elmer), and pyrolytically-coated graphite tubes. All digested samples were determined by the standard addition method.

RESULTS

During the 18-month inhalation period, the body weights were similar among the groups exposed to 25, 50 and 100 $\mu g/m^3$ as sodium dichromate ($Na_2Cr_2O_7$) aerosol and that group exposed to 100 $\mu g/m^3$ as a Cr(III)/Cr(VI) oxide (2:3) mixture (Cr_5O_{12}) as well as the controls. Thereafter, in the subsequent observation period all rats had lost weight. But for the whole time of the study, the mean body weight of the experimental groups did not differ significantly from that of the controls (Fig. 1). During this long-term study also, the food and water consumptions were similar between all experimental and control groups (data not shown).

At the end of the study more than 50% of the animals had survived. Seventeen out of 40 rats from controls had died or were killed when moribund (42.5% mortality). The mortality rates were 35%, 45% and 25% in the sodium dichromate groups exposed to 25, 50 and 100 $\mu g/m^3$, respectively. Ten out of 20 rats had survived in the group exposed to chromium oxide aerosol. The cumulative mortality incidences of the groups are shown in Fig. 2. There were similar mortality rates in all experimental and control groups.

During the whole study hematology revealed no significant differences between the controls and the $Na_2Cr_2O_7$ aerosol-exposed groups. However,

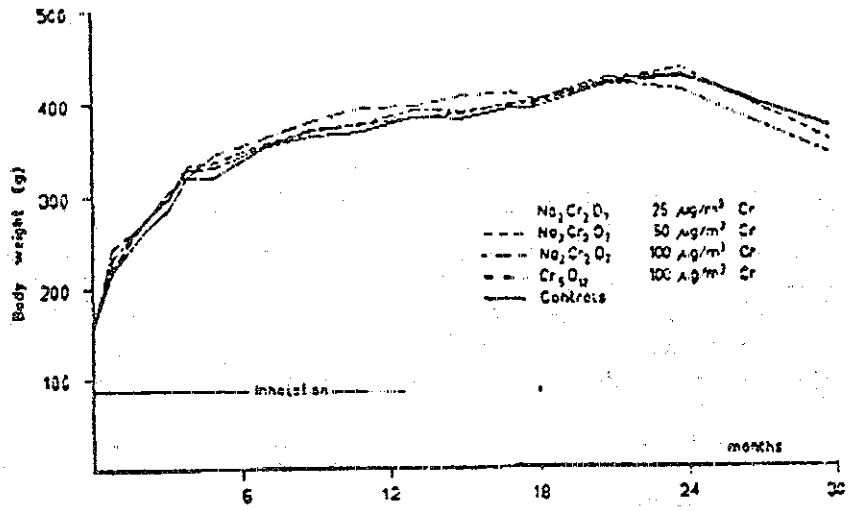

Fig. 1. Body weight. Means of the controls and the experimental groups continuously exposed to chromium aerosols ($Na_2Cr_2O_7$ sodium dichromate; Cr_5O_{12} chromium (VI)/(III) oxide (3:2) mixture) for 18 months and subsequently housed conventionally for a further year.

at the end of the inhalation period (17th to 18th month) slight increases of blood leukocytes were measured only in the Cr_5O_{12} aerosol groups. At this moment in this group the mean white blood cell count was $9.9 \times 10^9 \pm 1.5 \times 10^9$/l blood, which was significantly ($P < 0.01$) different from that of the controls ($7.3 \times 10^9 \pm 1.4 \times 10^9$/l blood). At the end of the study (27th

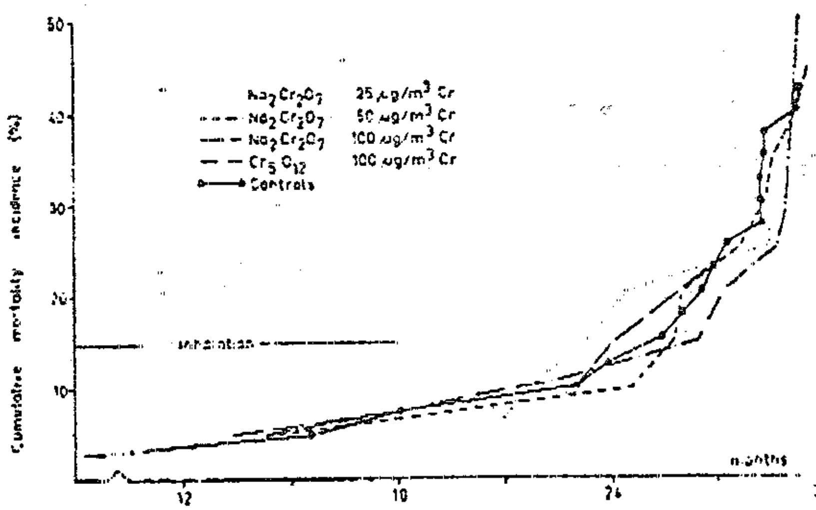

Fig. 2. Cumulative mortality incidence after 18 months continuous exposure to chromium aerosols ($Na_2Cr_2O_7$; sodium dichromate, Cr_5O_{12} : chromium(VI)/(III) oxide (3:2) mixture) in male rats.

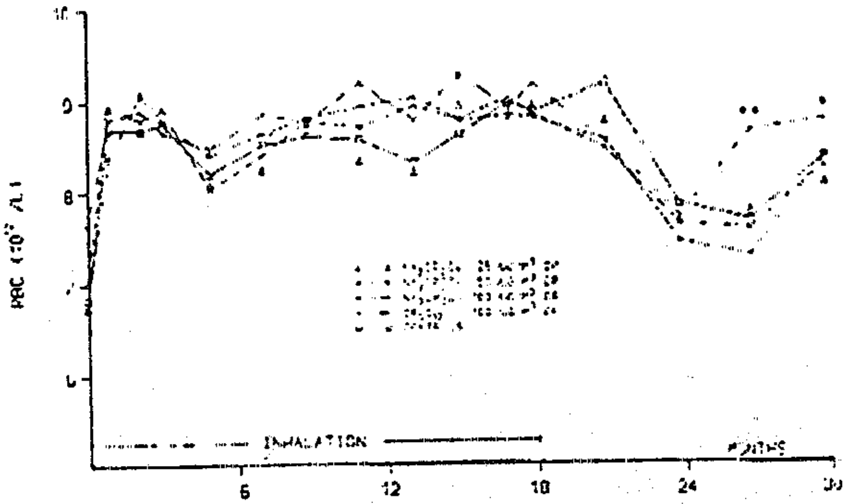

Fig. 3. Red blood cell (RBC) counts of male Wistar rats (means of 10 animals from each group) continuously exposed to sodium dichromate ($Na_2Cr_2O_7$) and chromium(VI)/(III) oxide (3:2) mixture (Cr_5O_{12}) aerosols for 18 months. (*$P < 0.05$ **$P < 0.01$, Student's t-test for the group vs. controls)

month) in this group also, the red blood cell counts (Fig. 3) together with the hematocrits and the blood hemoglobin levels (not shown) were significantly increased compared to the controls. The mean serum contents of total immunoglobulin were measured for 3 moments of the long-term inhalation

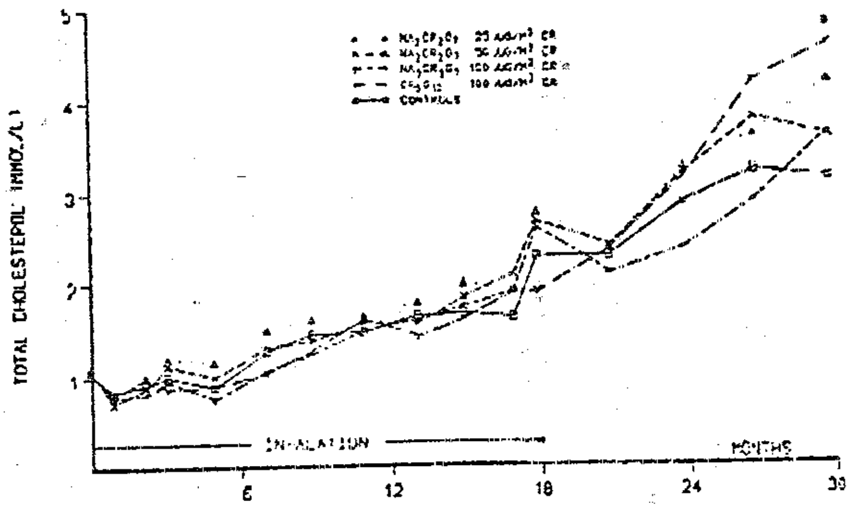

Fig. 4. Mean serum content of total cholesterol of male Wistar rats (10 animals from each group) continuously exposed to sodium dichromate ($Na_2Cr_2O_7$) and chromium(VI)/(III) oxide (3:2) mixture (Cr_5O_{12}) aerosols for 18 months (*$P < 0.05$ Student's t-test for the group vs. controls)

study (the 6th, 15th and 24th month). Compared to the controls in all chromate exposure groups only lower serum levels were measured; however, of significance ($P < 0.001$) were only the values in the chromium oxide group at the sixth month of exposure (data not shown). For the whole study similar serum activities of the alanine aminotransferase (GPT) and alkaline phosphatase were measured among the $Na_2Cr_2O_7$ and Cr_5O_{12} aerosol exposure groups and the controls (not shown). Similarly there were usually no significant differences between the aerosol exposure groups and controls for the serum lipids measured, for the triglycerides, the phospholipids (data not shown) and the serum total cholesterol. In Fig. 5 it is shown that this parameter is mainly affected by the age of the male rats, but at the end of the observation period only in the chromium oxide group exposed to 100 $\mu g/m^3$, significantly ($P < 0.05$) increased serum values were measured in comparison to the controls. Neither elevated serum urea levels nor increased

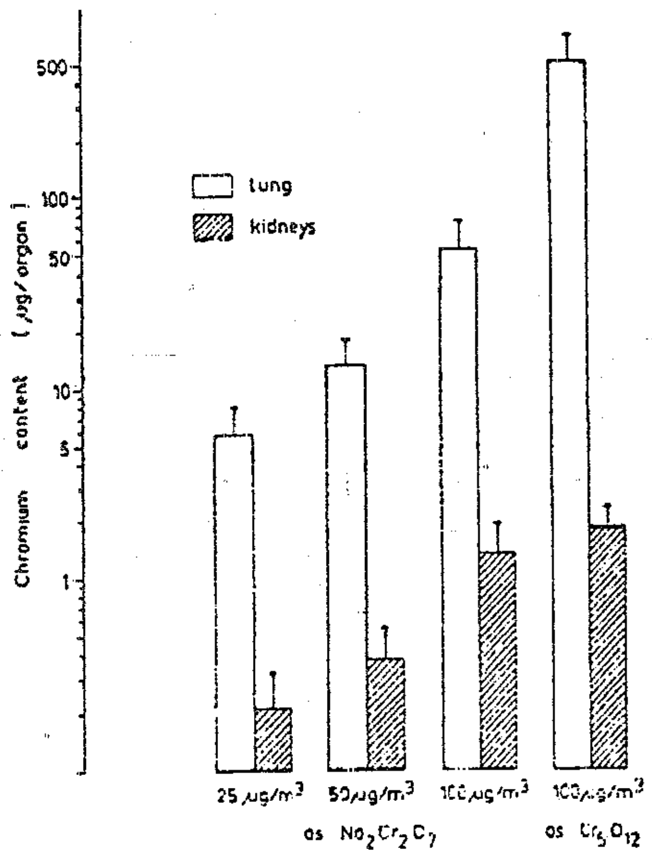

Fig. 6. Retention of chromium in lung and kidneys (μg Cr/organ; $\bar{x} \pm$ S.D. of 10 lungs or 6 kidneys of each group) 1 year after the termination of continuous exposures to sodium dichromate ($Na_2Cr_2O_7$) or chromium(VI)/(III) oxide (3 : 2) mixture (Cr_5O_{12}) aerosols for 18 months.

urine protein contents were determined among all the experimental groups (data not shown) for the whole study. For all surviving rats of the controls and also among all experimental groups similar tissue weights of the kidneys, adrenals, spleens and testes were measured. Significantly increased weights ($P < 0.05$) were determined for the lungs of the Cr_5O_{12} aerosol group exposed to 100 $\mu g/m^3$, and for the livers of the $Na_2Cr_2O_7$ aerosol group exposed to the same chromium aerosol level. At the Cr-aerosol concentration of 100 $\mu g/m^3$ for the surviving rats of the $Na_2Cr_2O_7$ and Cr_5O_{12} groups, the mean lung weights were 0.53 ± 0.13 g/100 g body wt and 0.58 ± 0.14 g/100 g body wt and for the controls only 0.46 ± 0.10 g/100 g body wt. At these aerosol levels the mean liver weights were 4.2 ± 0.7 g/100 g body wt for the $Na_2Cr_2O_7$ group and 3.8 ± 0.4 g/100 g body wt for the Cr_5O_{12} group. The mean liver weight of the controls was 3.7 ± 0.6 g/100 g body wt.

For a few rats of each group surviving the inhalation and observation periods the chromium contents of the lungs and kidneys were measured by atomic absorption spectroscopy. The results for the experimental groups are shown in Fig. 6. The mean chromium contents in the lung of the $Na_2Cr_2O_7$ aerosol groups exposed to 25, 50 and 100 $\mu g/m^3$ was found to be 5.8, 13.3, and 52.5 μg Cr/lung, respectively, while this value was 508.1 μg Cr/lung in the Cr_5O_{12} aerosol group exposed to 100 $\mu g/m^3$ and about 0.1 μg Cr/lung in the controls. One year after cessation of the inhalations the chromium contents in the kidneys were lower than in the lung, by factors of about 30 in the sodium dichromate aerosol groups and by a factor of about 300 in the chromium oxide aerosol group. The mean values were 0.21, 0.37 and 1.37 μg Cr/kidneys in the $Na_2Cr_2O_7$ exposure groups, respectively, 1.79 μg Cr/kidneys in the Cr_5O_{12} aerosol group and 0.05 μg Cr/kidneys in the controls (Fig. 6).

For pathological comparisons only those rats that died after two years of the study or which survived had been considered. Table II shows that this was the case for 37 rats of the controls, 18 rats for the sodium dichromate groups exposed to 25 and 50 $\mu g/m^3$ and the chromium oxide group and 19 out of 20 in the group exposed to 100 $\mu g/m^3$ as $Na_2Cr_2O_7$ aerosol. Histopathologically there were similar observations in several tissues, e.g. chronic nephrosis, among all of the experimental groups and the controls. However, the frequencies of some findings in the lung were different between the control and exposure groups. In the lungs of the control rats no pigment-loaded macrophages were found, while there were weak accumulations in the alveolar region of 8 rat lungs of the 25 $\mu g/m^3$ $Na_2Cr_2O_7$ exposure group, and moderate accumulations in the alveolar and peribronchial regions of all evaluated rats of the other chromium exposed groups. In the chromium oxide group 3 out of 18 rats had also accumulations of eosinophilic substance inside the alveolar lumens. Focal thickened septa were also found in the lungs of 3 rats in the Cr_5O_{12} group and in 2 cases combined with interestital fibrosis. Focal bronchiolo-alveolar hyperplasia was found once in each group.

Primary lung tumors were not found in the lower $Na_2Cr_2O_7$ aerosol

TABLE II

INCIDENCE OF PRIMARY TUMORS IN TISSUES OF MALE WISTAR RATS, CONTINUOUSLY EXPOSED TO SODIUM DICHROMATE ($Na_2Cr_2O_7$) AND CHROMIUM OXIDE (Cr_2O_3) AEROSOLS FOR 18 MONTHS AND SUBSEQUENTLY HOUSED INDIVIDUALLY FOR 12 FURTHER MONTHS

	Controls		$Na_2Cr_2O_7$ 25 μg/m³ Cr		50 μg/m³ Cr		100 μg/m³ Cr		Cr_2O_3 100 μg/m³ Cr	
	Total *n*	Malign *n*	Total *n*	Malign *n*	Total *n*	Malign *n*	Total *n*	Malign *n*	Total *n*	Malign *n*
Rats survived 2 years	37		18		18		19		18	
Rats with tumors	24		7		13		15		8	
Total tumor rate	32	9	10	3	16	4	24	10	13	5
Lung	—	—	—	—	—	—	3	1	1	—
Pharynx	—	—	—	—	—	—	1	1	—	—
Pituitary gland	—	—	—	—	—	—	2	—	—	—
Pancreas	—	—	—	—	—	—	2	1	—	—
Liver	—	—	—	—	—	—	1	1	1	—
Spleen	—	—	—	—	—	—	—	—	1	—
(*para*-)Thyroids	7	6	2	1	—	—	4	3	3	2
Adrenals	10	—	3	—	5	—	5	—	2	—
Bladder	6	1	3	—	2	—	3	1	1	—
Testes	8	—	—	—	4	—	—	—	—	—
Kidneys	1	—	—	—	—	—	—	—	—	—
Gastrointestinal tract	2	1	1	1	—	—	1	—	1	1
Muscles, heart	—	—	1	1	3	3	—	—	—	—
Skin and appendices	3	1	—	—	2	1	2	2	3	2

groups or in the controls. Primary lung tumors, 1 adenocarcinoma and 2 adenomas were evident in the $Na_2Cr_2O_7$ group exposed to 100 $\mu g/m^3$, and a further primary adenoma was found in the chromium oxide mixture group. In the higher $Na_2Cr_2O_7$ group there was another rat with a squamous cell carcinoma in the pharynx region (Table II).

Besides the respiratory tract tumors all other neoplasms listed in the Table II gave no indication of a carcinogenicity of the chromium compounds tested. The nasal cavities of the rats killed at the end of the study had neither hyperplastic changes nor tumors.

DISCUSSION

Soluble hexavalent chromium aerosols consisting, e.g. of sodium dichromate are known as strong oxidizers causing irritation of skin and mucous membranes at high dose levels. At lower air concentrations, for example at the Cr-exposure limit for work-places (TLV-value, 50 $\mu g/m^3$), the inhaled submicron particles are thought to be too short-lived inside the respiratory tract to induce long-term effects like primary lung tumors [24]. Inhalation of slightly soluble chromium(VI)/(III) oxide mixtures may cause persistence of the inhaled Cr-particles in the alveolar region, but it is questionable whether this also increases the chromium carcinogenicity [24].

In this inhalation study, in which male Wistar rats were continuously exposed for 18 months to both water soluble sodium dichromate ($Na_2Cr_2O_7$) and slightly soluble chromium oxide mixture (Cr_5O_{12}) aerosols no clinical signs of irritation were obvious. This may probably be due to the low Cr aerosol levels (25–100 $\mu g/m^3$) being not different from the TLV-value. During the inhalation and the subsequent observation period all animals appeared to be healthy: at 2 years of the study more than 90% of the rats were still alive. For the whole time of the study no significant effects were found from routine hematology and clinico-chemical examinations in all rats exposed to $Na_2Cr_2O_7$ aerosol. But in the group exposed to Cr_5O_{12} aerosol there were several findings of significance. Compared to the controls there were significant systemic effects, e.g. decreased serum immunoglobulin levels (6th month), slightly elevated white blood cell counts (at the end of inhalation), increased red blood cell counts, hematocrits, hemoglobin and serum cholesterol levels (at the end of observation). All these effects may be due to accumulation of chromium in the lung, which was predominantly found in this group. One year after the end of inhalation about 19% of all that chromium that was calculated*) to be deposited in the alveolar region during the inhalation period was found in the rat lungs of this Cr_5O_{12}-exposed group. In the $Na_2Cr_2O_7$-exposed rats this portion was 10 times lower. We assume that for the Cr_5O_{12}-exposed group Cr-accumulation in the lung was the result of decreased lung clearance functions which were also observed in rats subchronically exposed to high $Na_2Cr_2O_7$ aerosol levels (200 $\mu g/m^3$) [18]. In that subchronic inhalation study the diminished lung clearance functions were the result of cytotoxicity on alveolar macrophages connected

*Deposited Cr: 20% · Cr conc · 374 $\int_0^t$ (kg body wt)$^{0.8}$ · dt. Use of the assumption of 20% deposition rate and Stahl's formula for the average inspired volume, t in minutes.

also with depressions of the immune system. This reaction of the immune system was also found for the Cr_5O_{12}-exposed rats in this study.

The Cr(VI)/Cr(III) oxide mixture cannot be evaluated as a lower bioavailable Cr-compound. For both groups exposed to 100 $\mu g/m^3$ either as $Na_2Cr_2O_7$ or Cr_5O_{12} aerosols there was a similar chromium burden in the kidneys of the rats. Also several non-carcinogenic lung effects were seen histopathologically predominant in the rats exposed to slightly water soluble Cr_5O_{12} aerosol. Pigment-loaded macrophages were not found in the controls, but in the $Na_2Cr_2O_7$-exposed rats in a dose dependent manner and also in the Cr_5O_{12}-exposed animals. Focal thickened septa partially combined with interstitial fibrosis and accumulation of eosinophilic substance in the alveolar lumens were only observed in rats exposed to Cr_5O_{12} aerosol. These effects may be connected with the Cr-accumulation in the lungs and also due to the depressed lung clearance function. For instance the accumulation of eosinophilic proteins inside the lungs was shown in another long-term inhalation study with rats as a result of an impaired function of the alveolar macrophages for elimination of surfactant and other proteins from lung [25]. In that study alveolar proteinosis was the reason for an increase of hematopoesis [26] as also shown by this study. Altogether these observed effects may indicate that the Cr-aerosol levels were in a range maximally tolerated by the rats of the Cr_5O_{12}-exposed group.

More than 90% of the rats survived the 2-year period. Therefore this long-term inhalation study may be considered as a carcinogenicity study. It was found that among all rats exposed to Cr-concentrations, lower than 100 $\mu g/m^3$, and the controls there was no difference in tumor incidence of all tissues examined. Primary lung tumors also were neither found in the rats exposed to 25 and 50 $\mu g/m^3$ $Na_2Cr_2O_7$, nor in the controls. Primary lung tumors (2 benign and 1 malign) and 1 malign tumor of the pharynx were only found at the 100 $\mu g/m^3$ level for the $Na_2Cr_2O_7$ groups, and 1 benign lung tumor was observed for the Cr_5O_{12}-exposed rats. There were several extrapulmonary tumors (pituitary gland, pancreas, liver, spleen) that were also only found in rats exposed to Cr-concentrations of 100 $\mu g/m^3$ as $Na_2Cr_2O_7$ or Cr_5O_{12} aerosols, but these tumors could not significantly be attributed to the chromium exposure.

These findings indicate a weak carcinogenicity for chromium aerosols under the conditions of this study, where only Cr-concentrations of 100 $\mu g/m^3$ as $Na_2Cr_2O_7$ and Cr_5O_{12} aerosols were found to induce weak lung carcinogenic effects, thus confirming the results of Steinhoff et al. [16]. However, in order to come to a final statement concerning this weak carcinogenic potency of water soluble and slightly soluble chromate aerosol, further inhalation studies are needed, possibly using larger populations of animals and longer observation periods.

ACKNOWLEDGEMENTS

This research has been supported by Contract No 106 06 007/2 from the German Federal Environmental Agency. The authors are grateful to Prof. Dr.

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22 R. Helger, H. *Rindfrey and J. Hilgenfeldt*, Eine Methode zur direkten Bestimmung des Creatinins in Serum und Harn ohne Enteiweissung nach einer modifizierten Jaffé-Methode. Z. Klin. Chem. Klin. Biochem., 12 (1974) 344.

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24 National Institute for Occupational Safety and Health (NIOSH), Criteria for a Recommended Standard: Occupational Exposure to Chromium(VI). Washington, D.C.: U.S. Department of Health, Education and Welfare.

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RECORDED AT REQUEST OF
Coast Wood Pres
BOOK 1792 PAGE 564
Nov 29 2 56 PM '89
OFFICIAL RECORDS
MENDOCINO COUNTY CALIF
MARSHA A. YOUNG
RECORDER

COAST WOOD PRESERVING, INC.

UKIAH, CALIFORNIA

TOXIC SUBSTANCES CONTROL DIVISION
12-122
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MR
CALIFORNIA DEPARTMENT OF HEALTH SERVICES
RECEIVED

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Recording Requested by:
Coast Wood Preserving, Inc.

When Recorded, Mail to:

Department of Health Services
Toxic Substances Control Division
Region 2
2151 Berkeley Way, Annex 7
Berkeley, California 94704
Attention: Howard K. Hatayama, Chief

COVENANT AND AGREEMENT

This Covenant and Agreement ("Covenant") is made as of the 25 th day of September, 1989 by Coast Wood Preserving, Inc., a California Corporation, ("Covenantor") who is the owner of record of certain Property situated in Ukiah, State of California, described in Exhibit A, attached hereto and incorporated herein by this reference ("the Property") and by the California Department of Health Services, with reference to the following facts:

A. This Property has contained and currently contains hazardous waste.

B. This Property is the site of a wood preserving plant using chromated copper arsenate. In the process of using this

preservative some of the preservative has been released into the soil on-site. Various governmental agencies have overseen the investigation of the site and currently oversee activities conducted at the site.

Pursuant to Section 25355.5(a)(1)(B) of the Health and Safety Code, the Department issued a Remedial Action Order Docket No. HSA 88/89-015 on December 16, 1988 to require Coast Wood Preserving, Inc. to implement a Remedial Action Plan (RAP).

The RAP requires continued extraction and treatment of contaminated groundwater, and complete remediation of contaminated soil upon closure of the Property.

C. Contamination at the Property

1. Chromated copper arsenate is a wood preserving compound. Over the years of operation, the cumulative drippings or spillage of the chemical solution has resulted in soil and groundwater contamination.

2. Soil underlying the Property has been contaminated with chromium, arsenic and copper. Arsenic has been found in soils in concentrations as high as 220 parts per million (ppm), chromium in concentrations as high as 540 ppm and copper in concentrations as high as 230

ppm. Generally, concentrations are highest near the retort and sump areas.

3. Groundwater underlying and adjacent to the Property is contaminated with chromium (VI) and total chromium. Chromium (VI) and total chromium have been found in concentrations as high as 78 ppm.

D. Health Effects

ARSENIC (As)

The principal uses of arsenic and arsenic compounds are in pesticides, cotton desicants, textiles, glass, alloys and in the manufacture of integrated circuits. Arsenic is well absorbed via the oral, dermal and inhalation routes. Acute ingestion of a high dose of arsenic leads to a burning sensation in the mouth, nausea and vomiting. This is followed by muscular twitches, liver, kidney and heart dysfunctions and by delirium, coma and death. Chronic exposure to arsenic is associated with a persistent metallic taste in the mouth, hyperkeratosis, anemia and peripheral nerve disease. Chronic exposure to arsenic has also been shown to increase the risk of developing skin cancer, aplastic anemia and leukemia.

CHROMIUM (Cr)

Chromium is used in the metal, chemical, tanning, and paint industries. Chromium has two biologically important oxidation states, the trivalent (III) and hexavalent (VI) forms. Chromium (III) is a nutritionally essential trace metal thought to play a role in the metabolism of insulin and the regulation of blood glucose. Chromium (VI) is a corrosive and ulcerogenic agent. Chronic inhalation of chromium (VI) compounds have been associated with the development of lung disease including cancer in humans.

COPPER (Cu)

Copper is a nutritionally essential trace element. It is used extensively in a wide variety of industrial processes and salts of copper are also used as algicides and fungicides. Copper is well-adsorbed by the oral route. Acute inhalation of copper fumes or dust can result in a reversible influenza-like syndrome. Chronic ingestion of high levels of copper has been reported to cause hemolysis, fibrosis and cirrhosis of the liver, nervous system damage and kidney dysfunction.

E. Routes of Exposure and Population at Risk

There are several water wells within a one-mile radius of the Property. The Russian River is downgradient about half

a mile from the Property. Water wells and the Russian River are the primary water supply sources for the Ukiah region.

Chromium, arsenic and copper present in surface soil may be dispersed and become airborne if the asphalt pavement is not properly maintained. Potential routes of human exposure resulting from wind blown dust are inhalation or ingestion of contaminated particles in the air.

F. Covenantor desires and intends that in order to protect the present or future public health and safety, the Property shall be used in such a manner as to avoid potential harm to persons or Property which may result from hazardous wastes which have been deposited on the Property.

ARTICLE I

GENERAL PROVISIONS

1.01 <u>Provisions to Run with the Land</u>. This Covenant sets forth protective provisions, covenants, restrictions and conditions (collectively referred to as "Restrictions"), upon and subject to which the Property and every portion thereof shall be improved, held, used, occupied, leased, sold, hypothecated, encumbered, and/or conveyed. Each and all of the Restrictions shall run with the land, and pass with each and every portion, the Property, and shall apply to and bind the respective

successors in interest thereof. Each and all of the Restrictions are imposed upon the entire Property unless expressly stated as applicable to a specific portion of the Property. Each and all of the Restrictions are imposed pursuant to Section 25222.1 of the Health and Safety Code and run with the land pursuant to Section 25230(a)(1) of the Health and Safety Code. Each and all of the Restrictions are for the benefit of and enforceable by the Department.

1.02 <u>Concurrence of Owners Presumed</u>. All purchasers, lessees, or possessors of any portion of the Property shall be deemed by their purchase, leasing, or possession of such Property to be in accord with the foregoing and to agree for and among themselves, their heirs, successors, and assignees, and the agents, employees, and lessees of such owners, heirs, successors, and assignees that the Restrictions as herein established must be adhered to for the benefit of future Owners and Occupants and that their interest in the Property shall be subject to the Restrictions contained herein.

1.03 <u>Incorporation into Deeds and Leases</u>. Covenantor desires and convenants that the Restrictions set out herein shall be incorporated in, and this Covenant and Agreement shall be attached to, each and all deeds and leases of any portion of the Property.

ARTICLE III

DEVELOPMENT, USE AND CONVEYANCE OF THE PROPERTY

3.01 Restrictions on Use. Covenantor promises to restrict the use of the Property, as described in Exhibit A, as follows:

(1) No owner or occupant of the Property shall act in any manner that will aggravate or contribute to the existing contamination at the Property or interfere with the implementation of any remedial action at the Property.

(2) All owners and occupants of the Property or any portion thereof shall maintain an asphalt or concrete cap over the Property until such time as the soil remediation has begun in accordance with the approved RAP and Remedial Design (RD).

(3) In the event of any proposed earth movement or excavation by Owner or Occupant upon the Property, or any portion thereof, the Owner or Occupant of said Property shall notify and receive approval from the Director of such proposed activity 30 days prior to the beginning of such earth movement or excavation activities and shall:

(A) Comply with any applicable requirements of the California Occupational Health and Safety Agency, the Mendocino County Air Pollution Control District, the North Coast Regional Water Quality Control Board, the

United States Environmental Protection Agency, and the Department of Health Services;

(B) Utilize appropriate procedures to control dust during the period of earth movement or excavation;

(C) Handle all materials excavated on the premises as hazardous wastes unless shown otherwise by sampling and testing pursuant to the hazardous waste criteria set forth in Division 4, Chapter 30, Title 22, California Code of Regulations; and

(D) Protect any stockpiled hazardous waste from wind, rain, and any other condition which may cause the dispersal of any such hazardous waste.

In the event of an emergency any owner or occupant of the Property within twenty-four (24) hours of such an emergency may request permission from the Department by telephone for any proposed earth movement or excavation. The Department shall either approve or deny any such request within one business working day of receipt of such a request. A written report shall be submitted within five days of the Department's approval. The report shall include a description of emergency and its cause, period of time the proposed activity, and steps taken to eliminate the emergency.

(4) No owner or occupant of the Property shall disturb the interim asphalt and concrete cover, slurry wall, the function of any portion of the groundwater extraction and treatment system or monitoring system, or surface water run-off control other than routine maintenance in accordance with approved RAP and RD.

(5) Any or all wastes must be managed in accordance with all applicable requirements.

(6) No production wells shall be drilled without the express prior written approval of the Director and any other agency with jurisdiction. Monitoring or other test wells are not subject to this provision.

(7) Without the express prior written approval of the Director no construction or placement of a building or structure shall occur on the Property which is intended for use as any of the following, nor shall any new use of an existing structure or building on the premises occur as any of the following:

(A) A hospital;
(B) A school for persons under 21 years of age;
(C) A day-care center;
(D) Any permanently occupied human habitation other than those used for industrial purposes.

3.02 Conveyance of Property. Any prospective purchaser, lessee, or assignee of the Property or of an interest in the Property must demonstrate to the satisfaction of the Department that said purchaser, lessee or assignee of the Property is financially capable of implementing the selected remedial action for the Property. The Owner or Owners shall provide thirty (30) days advance notice to the Department of any sale, lease, or other conveyance of the Property or an interest in the Property to a third person. The Owner(s) shall provide information of intended use for the Property by subsequent owner to the extent the existing owner(s) have such information.

3.03 Enforcement. Failure of the Owner to comply with any of the requirements, as set forth in paragraph 3.01 above, shall be grounds for the Department, by reason of the Covenant, to require that the Owner or Occupants modify or remove any Improvements constructed in violation of the paragraph. This Covenant shall be enforceable by the Department pursuant to Section 25236 of the Health and Safety Code.

3.04 Notice in Agreement. All Owners and Occupants shall execute a written instrument which shall accompany all purchase, lease, sublease, or rental agreements relating to the Property. The instrument shall contain the following statement:

> The land described herein contains hazardous waste. Such condition renders the land and the owner, lessee, or other

possessor of the land subject to requirements, restrictions, provisions, and liabilities contained in Chapter 6.5 (commencing with Section 25100) of Division 20 of the Health and Safety Code. This statement is not a declaration that a hazard exists.

3.05 Disclaimer. The State of California makes no representations as the suitability of the Property for any particular purpose.

ARTICLE IV

VARIANCE AND TERMINATION

4.01 Variance. Any Owner or, with the Owner's consent, any Occupant of the Property or any portion thereof may apply to the Department for a written variance from the provisions of this Covenant. Such application shall contain 1) a statement of who is applying for the variance; 2) the proposed variance; and 3) a statement of reasons in support of the granting of the variance. In addition, the owner shall demonstrate to the satisfaction of the Department that the proposed variance will not cause or allow any of the following effects associates with hazardous waste or extremely hazardous waste:

A. The creation or increase of significant present or future hazards to the public.

B. Any significant diminution of the ability to mitigate any significant potential or actual hazard to public health.

C. Any long-term increase in the number of humans or animals exposed to significant hazards which affect the health, well-being, or safety of the public.

Upon making a decision to approve or deny the proposed variance, the Director shall issue and cause to be served the decision and findings of fact on the owner of the land, the legislative body of the city or county in whose jurisdiction the land is located, and upon any other interested persons. If the Department agrees to the proposed variance, the director and all of the owers of the land shall execute an instrument reflecting this agreement, shall particularly describe the real property affected by the variance, and the owner shall record the instrument in the county in which the land is located within ten (10) days of the date of execution.

4.02 <u>Termination</u>. Any Owner or, with the Owner's consent, an Occupant of the Property or a portion thereof may apply to the Department for a termination of the Restrictions as they apply to all or any portion of the Property on the ground that the waste no longer creates a significant existing or potential hazard to present or future public health or safety. Any

application shall contain sufficient evidence for the Department to make a finding upon any or all of the following grounds:

A. The hazardous waste which caused the land to be contaminated has since been removed or altered in a manner which precludes any significant existing or potential hazard to present or future public health.

B. New scientific evidence is available concerning either of the following:

1. The nature of the hazardous waste contamination; or
2. The geology or other physical environmental characteristics of the contaminated land.

Upon making a decision to approve or deny the proposed termination, the Director shall issue and cause to be served the decision and findings of fact on the owners of the land, the legislative body, and the city or county in whose jurisdiction the land is located, and upon any other interested person. If the Department approves, in writing, the proposed termination of the Restrictions, the Director and all of the owners of the land shall record or cause to be recorded, a termination of the Restrictions which shall particularly describe the real property subject to the Restrictions and which shall be indexed by the recorder in the grantor index in the name of the record title

owner of the real property subject to the Restrictions, and in the grantee index in the name of the Department.

4.03 <u>Term</u>. Unless terminated in accordance with paragraph 4.02 above, by law or otherwise, this Covenant shall continue in effect in perpetuity.

ARTICLE V
MISCELLANEOUS

5.01 <u>No Dedication Intended</u>. Nothing set forth herein shall be construed to be a gift or dedication, or offer of a gift or dedication, of the Property or any portion thereof to the general public or for any purposes whatsoever.

5.02 <u>Notices</u>. Whenever any person gives or serves any notice, demand, or other communication with respect to this Covenant, each such notice, demand, or other communication shall be in writing and shall be deemed effective 1) when delivered, if personally delivered to the person being served or to an officer of a corporate party being served or official of a government agency being served, or 2) three (3) business days after deposit in the mail if mailed by United States mail, postage paid certified, return receipt requested:

To: Harold Logsdon
Coast Wood Preserving, Inc.
P.O. Box 673
Ukiah, CA 95482

Copy To: Department of Health Services
Toxic Substances Control Division
Region 2
2151 Berkeley Way, Annex 7
Berkeley, CA 94704
Attention: Regional Section Chief

5.03 Partial Invalidity. If any portion of the Restriction set forth herein or terms is determined to be invalid for any reason, the remaining portion shall remain in full force and effect as if such portion had not been included herein.

5.04 Article Headings. Headings at the beginning of each numbered article of this Covenant are solely for the convenience of the parties and are not a part of the Covenant.

5.05 Recordation. This instrument shall be executed by the Covenantor, and by the Director, California Department of Health Services. This instrument shall be recorded by the Owners in the County of Mendocino within ten (10) days of the date of execution.

5.06 References. All references to Code sections include successor provisions.

IN WITNESS WHEREOF, the parties execute this Covenant as of the data set forth above.

COAST WOOD PRESERVING, INC.

By: Harold W. Logsdon

Harold W. Logsdon

Title: President

Date: Sept. 25th 1989

DEPARTMENT OF HEALTH SERVICES

By: Howard K. Hatayama

Howard K. Hatayama

Title: Reg Administrator, TSCP

Date: 10/3/89

STATE OF CALIFORNIA)
)
COUNTY OF ALAMEDA)

On Oct 3, 1989, before me, the undersigned, a Notary Public in and for said state, personally appeared Howard K. Hatayama, personally known to me or proved to me on the basis of satisfactory evidence to be the person who executed the within instrument as Regional Administrator, Region 2, Toxic Substances Control Program, Department of Health Services, of the agency that executed the within instrument, and acknowledged to me that such agency executed the same.

WITNESS my hand and official seal.

~~OFFICIAL SEAL~~
~~CHARLOTTE M JACKSON~~
~~NOTARY PUBLIC - CALIFORNIA~~
~~ALAMEDA COUNTY~~
~~My comm. expires MAR 2 , 1990~~

OFFICIAL SEAL
CHARLOTTE M JACKSON
NOTARY PUBLIC - CALIFORNIA
[illegible] COUNTY
[illegible] MAR 23, 1990

Charlotte M. Jackson
Notary Public in and for said County and State

STATE OF CALIFORNIA)

)

COUNTY OF STANISLAUS)

On Sept. 25, , 1989, before me, the undersigned, a Notary Public in and for said state, personally appeared Harold Logsdon, personally known to me or proved to me on the basis of satisfactory evidence to be the person who executed the within instrument as President of the corporation that executed the within instrument, and acknowledged to me that such corporation executed the same pursuant to its bylaws or a resolution of its board of directors.

WITNESS my hand and official seal.

Alicia Isley

Notary Public in and for said County and State

OFFICIAL SEAL
ALICIA ISLEY
NOTARY PUBLIC — CALIFORNIA
COUNTY OF STANISLAUS
My Comm. Expires January 11, 1993

COURT PAPER
STATE OF CALIFORNIA
STD 113 (REV 8-72)

85 34769

EXHIBIT A

The description of the two lots are as follows:

BEGINNING at the point of intersection of the South line of Lot 70 of the Yokayo Rancho, with the East line of Parcel One, as conveyed in the deed executed by Edgar W. Dutton et al. to State of California, dated November 29, 1961, recorded February 1, 1962, in Volume 588 of Official Records, page 142, Mendocino County Records; thence along the exterior boundary of said Parcel One, North 5 degrees 52' 45" West 342.86 feet; thence continuing North 5 degrees 52' 45" West 145.0 feet; thence North 80 degrees 37' 15" East 386.91 feet to the South line of the 50 foot road described in the deed to City of Ukiah, recorded June 8, 1956 in Volume 432 of Official Records, page 543, Mendocino County Records; thence along the South line of said road Easterly to the West line of Parcel Two as conveyed in said deed (588 O.R.142); thence along said West line of Parcel Two South 7 degrees 20' 46" East 354.23 feet to the said South line of Lot 70; thence Westerly along said South line to the point of beginning.

PARCEL 2, as numbered and designated on the Parcel Map filed April 24, 1974 in Map Case 2, Drawer 23, Page 89, Mendocino County Records.

APPENDIX H

Coast Wood Preserving Inc.

Analysis of Public Comments Received on Draft RAP

June 1989

On May 25, 1989, the California Department of Health Services held a public meeting on the proposed remedial action plan for the Coast Wood Preserving site, located in Ukiah, Mendocino County, California. The purpose of the meeting was to provide the public with information regarding the remedial action plan (RAP) and to solicit public comments on the adequacy of the plan. In addition, from May 9, 1989 to June 8, 1989, the California Department of Health Services held a public comment period on the draft remedial action plan.

There were no written public comments received by the Department on the draft RAP, during this comment period. Therefore, the draft RAP will be approved as the final RAP.

A copy of the transcript of the public meeting is available for review at:

Department of Health Services
Toxic Substances Control Division
5850 Shellmound St. Suite 100
Emeryville, CA 94608

Mendocino County Library
105 N. Main St.
Ukiah, CA 95402

FINAL REMEDIAL ACTION PLAN AMENDMENT APPROVAL RECORD
SIGN-OFF SHEET

Coast Wood Preserving, Inc.

Mark E. Piros — 7/15/99

Project Manager — Date

[signature] — 7-15-99

Unit Chief — Date

Barbara J. Cook — 7-15-99

Branch Chief — Date

PROPOSED AMENDMENT
TO THE
REMEDIAL ACTION PLAN
FOR
COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

May 19, 1999

Prepared for:

Coast Wood Preserving, Inc.,
Plant Road and Taylor Drive
Ukiah, CA

Prepared by:

Montgomery Watson
1340 Treat Blvd., Suite 300
Walnut Creek, CA 94596

Submitted by:

Terry James
Professional Geologist

REGISTERED GEOLOGIST
RICHARD M. THOMASSER
NO 6256
Exp. 11/99
STATE OF CALIFORNIA

Approved by:

Richard M. Thomasser, RG, REA
Principal Hydrogeologist
Project Director

1.0 INTRODUCTION

This document has been prepared for Coast Wood Preserving, Inc., (CWP) to propose an amendment to the Remedial Action Plan (RAP) established for the CWP site in Ukiah, California. The original RAP was prepared by Geosystem Consultants, Inc., and approved by the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) in September 1989. This amendment to the RAP presents enhancements to the remedial action program in place for soil and groundwater at the site. CWP understands that a 30-day public comment period is required before approval of this amendment.

1.1 Site Background

The CWP site is located at the intersection of Taylor and Plant Roads in the city of Ukiah (Figure 1). CWP has used the site for wood preserving operations utilizing copper, chromate and arsenic solutions since 1971. In the early 1980's, groundwater impacts related to these operations were observed. Several phases of investigation and remediation have been conducted to characterize impacts to soil and groundwater. A more complete description of site activities including investigations, and remedial actions is provided in the RAP prepared for the site (Geosystem, 1989).

1.2 Purpose and Objectives

The purpose of amending the RAP is to incorporate technical advances made in the field of metals remediation into the selected remedy. Since the RAP was prepared and the Record of Decision (ROD) was signed in 1989 by US EPA, new technology has become available which has been proven to be more effective in remediating hexavalent chromium than the current groundwater extraction and treatment system operating at the site. As recommended by US EPA, the revision of the remedy selected for this site would:

> "*...bring past decisions into line with the current state of knowledge with respect to remediation science and technology, and by doing so, improve the cost effectiveness of site remediation while ensuring reliable short and long term protection of human health and the environment.*" (*Superfund Reforms: Updating Remedy Decisions*, US EPA 1996).

The technology that is being recommended to enhance remedial actions for this site is *in-situ* geochemical reduction. The proposed plan is to continue to execute all of the elements of the original selected remedy for the site in addition to implementing *in-situ* technology.

The purpose of this RAP Amendment document is to briefly describe the proposed technology and conceptual approach for implementation. A more detailed Remedial Design (RD) document will be prepared that provides additional information regarding the specific design and methodology for implementation of this technology. A draft of the RD document was submitted

to DTSC and the RWQCB on February 5, 1999. The RD will be finalized upon receipt of comments from DTSC and the RWQCB and pending approval of this RAP Amendment.

2.0 DESCRIPTION OF EXISTING REMEDIAL ACTION

The selected remedial action as presented in the RAP includes abatement measures such as controlling storm water run-off and reusing collected water as process water, as well as active remediation in the form of extraction and treatment of groundwater (pump and treat). The site has, and is currently implementing the remedial alternative selected by the RAP with the exception of active treatment of the soils since the site is still performing wood treatment operations.

2.1 Remedial Action Components

The selected remedy currently includes:

- Paving of exposed soils to prevent surface water infiltration and leaching of chromium from soils to groundwater
- On site treatment of impacted soils using best available technology, following termination of wood treatment operations
- Hydraulic control of impacted groundwater using extraction wells
- Electrochemical treatment of extracted groundwater
- Reuse, recycling or downgradient reinjection of treated groundwater
- Groundwater monitoring and sampling to ensure the effectiveness of remedial measures

2.2 Remedial Effectiveness

The remedial measures referenced above have been effective in limiting further impact to the soils and groundwater at the site. In addition to the groundwater extraction outlined above, CWP installed a cutoff wall/recovery trench (HL-7) near the southeastern (downgradient) boundary of the site to further limit the migration of impacted groundwater. These measures have been effective in controlling the plume of hexavalent chromium in the groundwater. Specifically, these measures have maintained hydraulic control of the plume. The levels of hexavalent chromium detected in the groundwater remain relatively constant. Based on experience with similar sites underlain with inter-bedded fine grained soil, traditional pump and treat technology will require many years to reach cleanup levels, and may not be technically feasible or financially practical.

3.0 *IN-SITU* GEOCHEMICAL FIXATION TECHNOLOGY

In-situ geochemical fixation is a proven and innovative technology for the remediation of chromium-impacted soil and groundwater. Experience with this technology has shown a significant reduction in the time required to reach clean-up levels as compared to conventional pump and treat approaches alone. Additionally, there is a reduction in the volume of waste generated (via groundwater extraction and treatment), therefore making this approach more economical. Chemically reducing the hexavalent chromium *in-situ* allows the use of natural groundwater flow dynamics as well as naturally occurring physical processes to augment the remediation of the soil and groundwater. This technology has shown a significant and lasting effect on the impact of hexavalent chromium in groundwater and soil at other wood preserving sites. Appendix A includes additional information regarding *in-situ* geochemical fixation, provided in support of this proposed RAP Amendment.

3.1 Background

This technology has been tested and implemented at several sites in the United States and abroad. The technology includes the use of a chemical reductant to reduce hexavalent chromium, which is highly soluble (therefore relatively mobile in groundwater), to trivalent chromium which is relatively insoluble. Additionally, hexavalent chromium is considered toxic and carcinogenic, whereas trivalent chromium is considered non toxic. The amount of chromium added to the soil by the fixation of trivalent chromium is insignificant when compared to background (naturally occurring) levels of chromium and does not represent a threat to human health or the environment (see section 4.2). Experience with similar wood preserving sites has shown calcium polysulfide to be the most effective reductant.

3.2 Experience with *In-Situ* Reduction for Treatment of Chromium-Impacted Soils and Groundwater

Approval has been granted to operate full-scale remedial programs using calcium polysulfide at similar wood preserving sites in California under approval by the Regional Water Quality Control Board (RWQCB) and the US EPA.

Locally (North Coast RWQCB region), a full-scale remediation program is being conducted at a wood treatment facility in Windsor, California. This technology was initiated at the site in 1996 in the shallow groundwater and vadose zones. There has been a reduction in the size of the hexavalent chromium plume in the shallow groundwater at this site of approximately 75%. The vadose zone (soil) treatment at the Windsor site has shown a similar effect.

4.0 USE OF *IN-SITU* GEOCHEMICAL FIXATION AS AN ADDITIONAL REMEDIAL MEASURE AT COAST WOOD PRESERVING

A variety of approaches have been used for delivery of the chemical reductant to impacted soil and groundwater, depending on site specific conditions and remedial objectives. A typical approach is to enhance a pump and treat approach by amending extracted and treated groundwater with chemical reductant and re-inject the amended water in upgradient wells or plume periphery wells. This approach is highly successful, generally resulting in rapid plume cleanup if the aquifer is relatively permeable and homogeneous. One such site located in Turlock, California has been operating, with better than expected results, for approximately one year under US EPA approval. However, when the aquifer contains significant fine-grained material, as is the case at the CWP site, dispersement of the reductant in the aquifer can be more difficult and other delivery techniques must be used. Infiltration of reductant through impacted vadose zone soils and/or direct pressure injection of reductant into highly-impacted portions of the saturated zone has been used. This approach has been successfully used at a site in Windsor, California at which the geology is very similar to the CWP site. An alternative passive approach involves creating a geochemical barrier or treatment zone at the downgradient edge of the plume to limit further migration. Experience with this technology has shown that the best approach usually involves performing treatment in phases using the results of groundwater monitoring and sampling as the basis for additional reductant injection or infiltration.

4.1 Design Basis

This section describes the design basis for the implementation of the *in-situ* fixation of hexavalent chromium in soil and groundwater at the CWP site. The site is underlain predominantly by interbedded, fine-grained sediments (interbedded clays, silts, and gravelly clays). Elevated concentrations of chromium in soil (greater than 100 mg/Kg) have been detected in the areas shown in Figure 2. First groundwater occurs between approximately 3 to 15 feet below surface grade, with a south-easterly flow direction. Seasonal groundwater level fluctuations are observed, with groundwater being encountered very close to surface grade in the late winter months following the significant precipitation received in the site vicinity. The shallow groundwater exhibits concentrations of dissolved chromium ranging from less than 0.005 to approximately 3.0 parts per million (Figure 2). The current remedial activities have been effective in preventing significant off site migration of the plume.

4.2 Conceptual Approach

Based on the geologic conditions encountered at the site, direct pressure injection of reductant into impacted portions of the shallow groundwater zone is anticipated to provide the best results in achieving remedial objectives for groundwater. The existing pump and treat remedial action elements will continue as set forth in the RAP. The approach to address both soil and groundwater impacts is discussed below.

4.2.1 Soil

Prior to developing any potentially-needed remedial approaches for the soil, additional evaluation of the presence of residual hexavalent chromium in soil is appropriate. Experience has shown that the most appropriate evaluation of residual impact in soil that may continue to threaten groundwater quality is through analysis of soil pore moisture.

Pressure-vacuum lysimeters will be installed in locations which are reported to have elevated concentrations of chromium detected in the soil (see Figure 2). Lysimeters allow the collection of pore water samples. If based on the results of the lysimeter data it appears that there is mobile hexavalent chromium within the vadose zone in the source areas, direct application of the reductant into the vadose zone is the most successful method of treatment. Based on experience at similar wood preserving sites, the most effective method is infiltration galleries. These galleries are constructed by trenching throughout the source area to approximately 3 ft. bsg, backfilling the trenches with permeable material, and infiltrating reductant directly into the vadose zone.

At this time, it is technically impractical to install these infiltration galleries into the active operations areas. However, until treatment can be safely accomplished in the operations area, in addition to the approach described below for groundwater, it is proposed that existing well CWP-19 and the associated injection trench and three existing shallow wells (screened across the vadose and shallowmost saturated zone) be used to deliver the reductant upgradient of the source area (Figure 3).

During periods of high groundwater elevations, reductant addition to the upgradient trench and shallow wells will allow infiltration into shallow permeable fill material underlying the plant. Based on the very shallow depth of groundwater during the winter months (within three feet of the ground surface), treatment of the majority of the chromium impacts in soil at the site using this approach is anticipated. Additionally, by introducing the reductant in the vadose zone upgradient during periods of lower groundwater levels, the natural groundwater flow assisted by downgradient pumping (HL-7) will pull reductant under the source area addressing impacts to the shallow groundwater under the plant. If residual hexavalent chromium is detected in the soil pore moisture in other potential source areas, such as the area south of the active wood treatment area, a specific remedial design work plan to address these impacts will be developed. The approach to address these soil zone impacts would conceptually be as described above (i.e via infiltration or additional direct injection in source areas).

4.2.2 Groundwater

As stated above, direct injection of reductant into impacted portions of the shallow groundwater zone is proposed. The direct injection will be accomplished using a Geoprobe™ rig to push 3/4-inch injection pipes to a target depth at each location (actual locations to be determined based on site conditions). At each location, the pipes will be withdrawn 5 feet and a calculated volume of 29 % calcium polysulfide will be injected using a piston pump. Following the reductant, a

calculated volume of water will be injected at each of the locations to assist in dispersing the reductant solution. Additional details concerning the actual locations for the direct injection and calculated volumes of reductant and water will be presented in the Remedial Design. However, the areas to be specifically considered are illustrated on Figure 3. These areas were selected based on the observed concentrations of chromium in groundwater and also based on site constraints posed by the active wood treatment operations. Additional injection locations may be determined in the future pending the results of continued groundwater monitoring and sampling.

As shown on Figure 3, it is proposed that a series of injection points be performed along several transect lines to deliver reductant to accessible key impacted areas of groundwater:

A line of injection points will be placed from the area of CWP-20 to the northwest and then north, along the east and north extent of the wood treating operations, forming a reactive barrier to ensure that the plume will not migrate around the north end of the cutoff trench/slurry wall.

A "U" shaped line of points is to be placed on the south, east, and north side of the tank farm to aid in addressing the source area. In addition, 2 additional east-west injection lines are proposed immediately southwest of the retort area in the heart of the dissolved chromium plume to address this critical area. This area is considered to be located as close to the source as currently practical. The areas closer to the retort are paved with concrete, and penetration of the concrete to deliver reductant is not recommended at this time.

A north-east, south-west trending line will be emplaced across the center of the shallow plume, to reduce the time for remediation by achieving *in-situ* fixation of chromium as the groundwater migrates from the source area toward the recovery trench, HL-7.

Additional injections will be placed throughout the body of the plume where access allows to deliver reductant to the shallow saturated zone.

In addition, to address the concern that dissolved chromium may be migrating beneath the slurry wall into deeper groundwater (as evidenced by the results of routine sampling of CWP-8):

A downgradient reactive barrier will be established in a north-south direction, east of the cut-off trench/slurry wall into Zone 2 to a depth of 25 feet bsg. The injection will consist of a line of injection points spaced approximately twenty feet apart from a point south of CWP-8 to a point north of CWP-22

Once injected, the reductant will come into contact with residual hexavalent chromium and achieve reduction of hexavalent chromium to the trivalent form, followed by the sorption of the trivalent chromium onto aquifer solids. The amount of trivalent chromium that will sorb onto the soil is estimated to increase chromium concentrations by approximately 5% in comparison to the

existing background values of trivalent chromium in the aquifer solids. Furthermore, the trivalent chromium sorbed on aquifer solids is highly insoluble thus eliminating the threat of continued groundwater impact. The residual chromium levels will pose no threat to human health or the environment.

As stated above, existing downgradient extraction well HL-7 will continue to be pumped to maintain hydraulic control of the plume and aide in dispersion of the reductant throughout the impacted area of the plume. As the reductant front migrates through the aquifer from points of injection toward monitoring wells and HL-7, water quality parameters will be monitored to evaluate remedial progress. Furthermore, extraction will continue at HL-7 until chromium concentrations decline to below the applicable MCL of 0.05 mg/L dissolved chromium. Based on experience, elevated sulfate levels (or other changes to general water quality) are not expected. Water quality monitoring will be performed to ensure that extracted water is of appropriate quality for reuse in the wood preserving process, and treated water discharged into the reinjection well does not exceed waste discharge requirements.

5.0 PERFORMANCE STANDARDS

Performance standards originally established for the site will remain unchanged. The state and federal agencies responsible for overseeing the CWP remedial activities include the DTSC, RWQCB and the EPA. As stated in the ROD, the goal of the remedial efforts is to ensure that the remedy be "*... protective of human health and the environment, attain Federal and State requirements that are applicable or relevant and appropriate to the remedial action, and is cost and time effective.*"

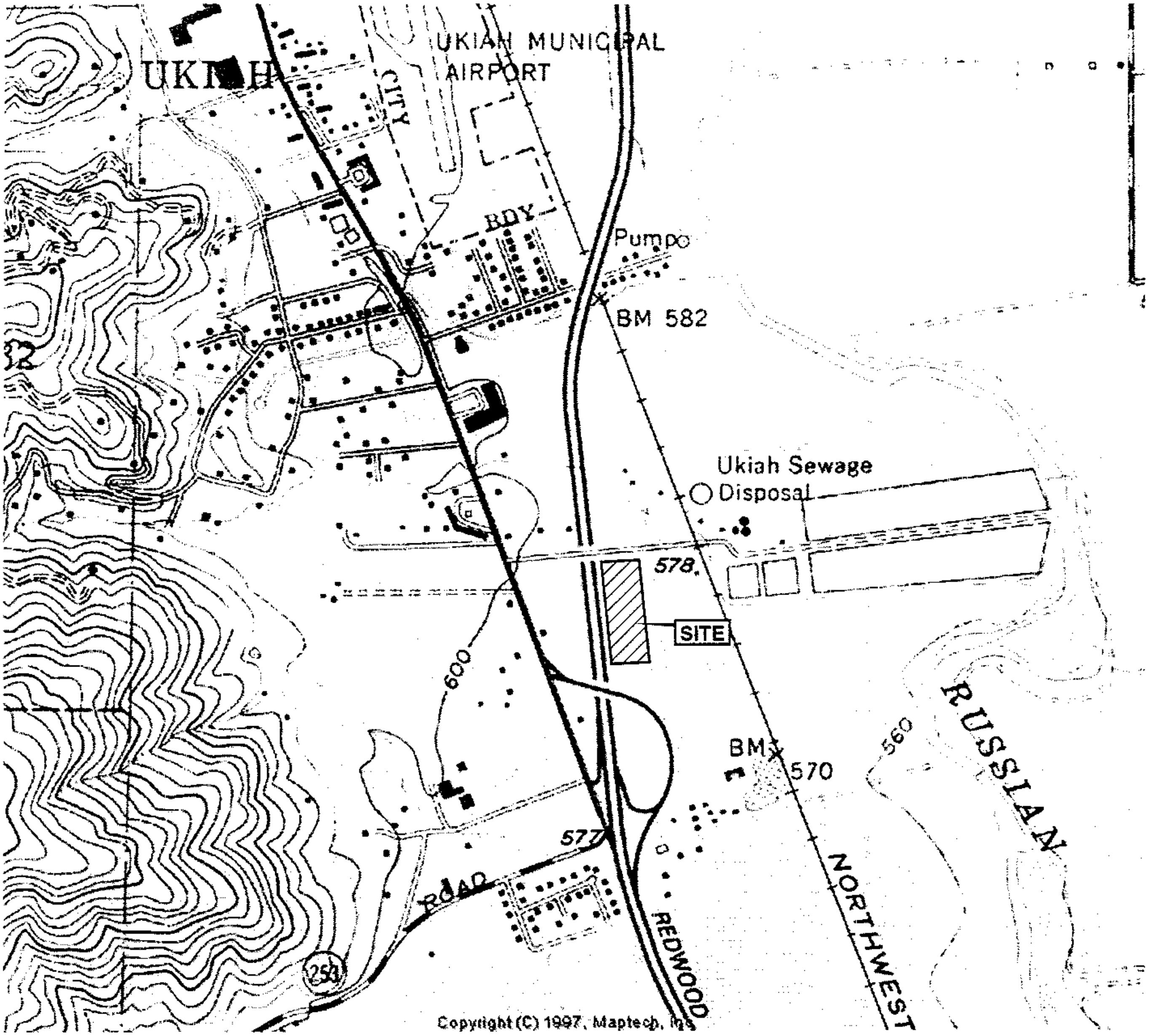
6.0 MONITORING

The routine groundwater monitoring and sampling program which CWP currently executes will continue as required by the RWQCB. Additionally, prior to beginning the direct injection, as a baseline, groundwater samples will be collected from all appropriate onsite monitoring wells. Specific wells to be sampled will be discussed in the Remedial Design. The groundwater samples will be analyzed for total dissolved chromium and sulfate. After the injection event, select wells will be sampled monthly and quarterly as discussed in the Remedial Design. Six months and one year following the injection event, all the appropriate wells on site will be sampled again.

Lysimeters installed to evaluate the presence of residual hexavalent chromium in the vadose zone will be sampled quarterly during the first year after installation. Continued monitoring will be based on the results. Samples will be collected for total dissolved chromium analysis.

7.0 SCHEDULE

A schedule for the project is attached in Appendix B As stated above, the draft document *Remedial Design, Remedial Action Plan Amendment, Coast Wood Preserving, Ukiah, California*, dated February 5, 1999 provides more specific details regarding the proposed remedial action enhancements. Coast Wood Preserving is prepared to begin implementing the *in situ* chromium reduction program immediately pending approval by the interested parties.



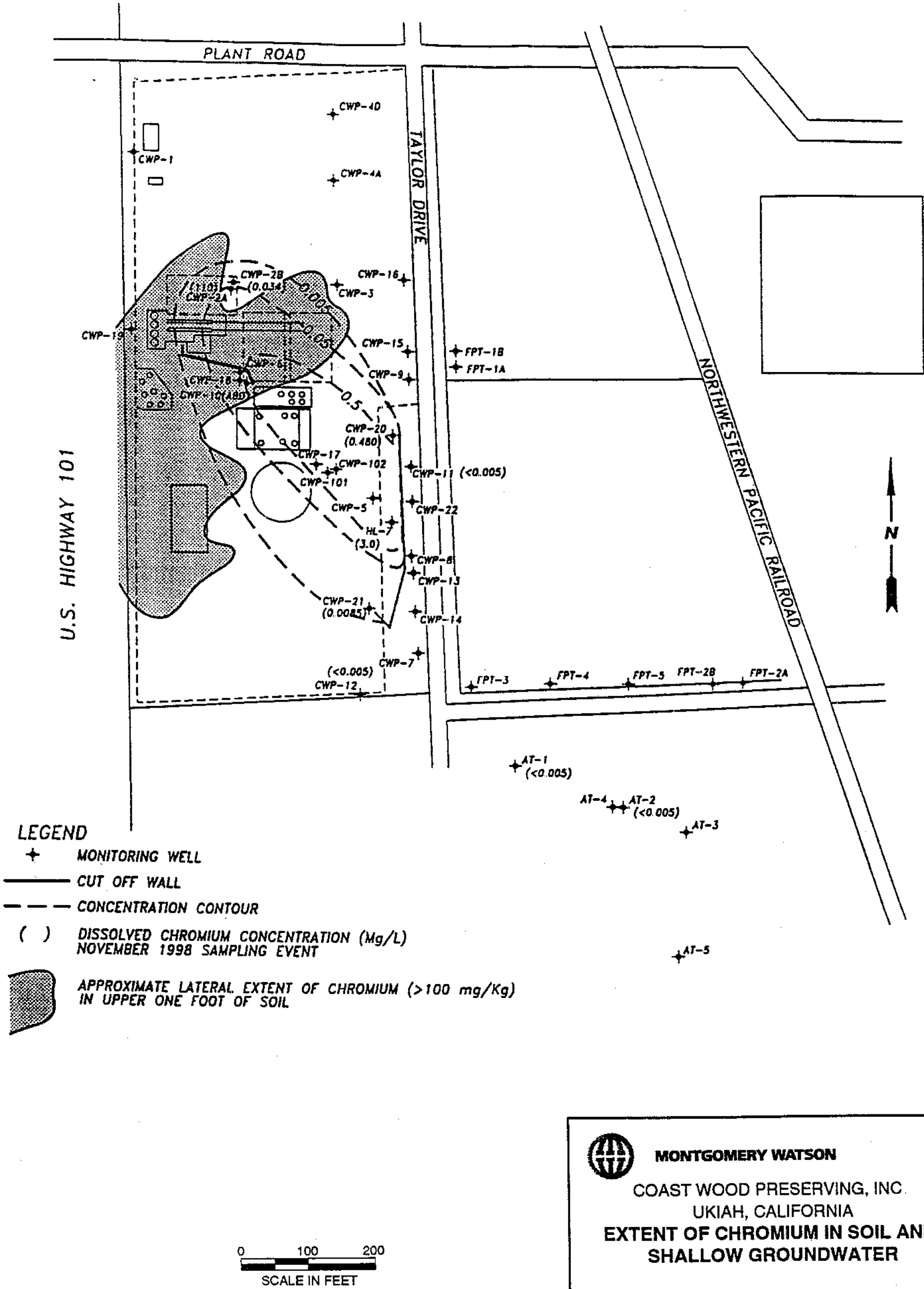
Scale: 1:24,000
USGS Topographic Map 7 5' Elledge Peak . 1980

06-99.CWP

MONTGOMERY WATSON

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA
SITE LOCATION MAP

FIGURE 1



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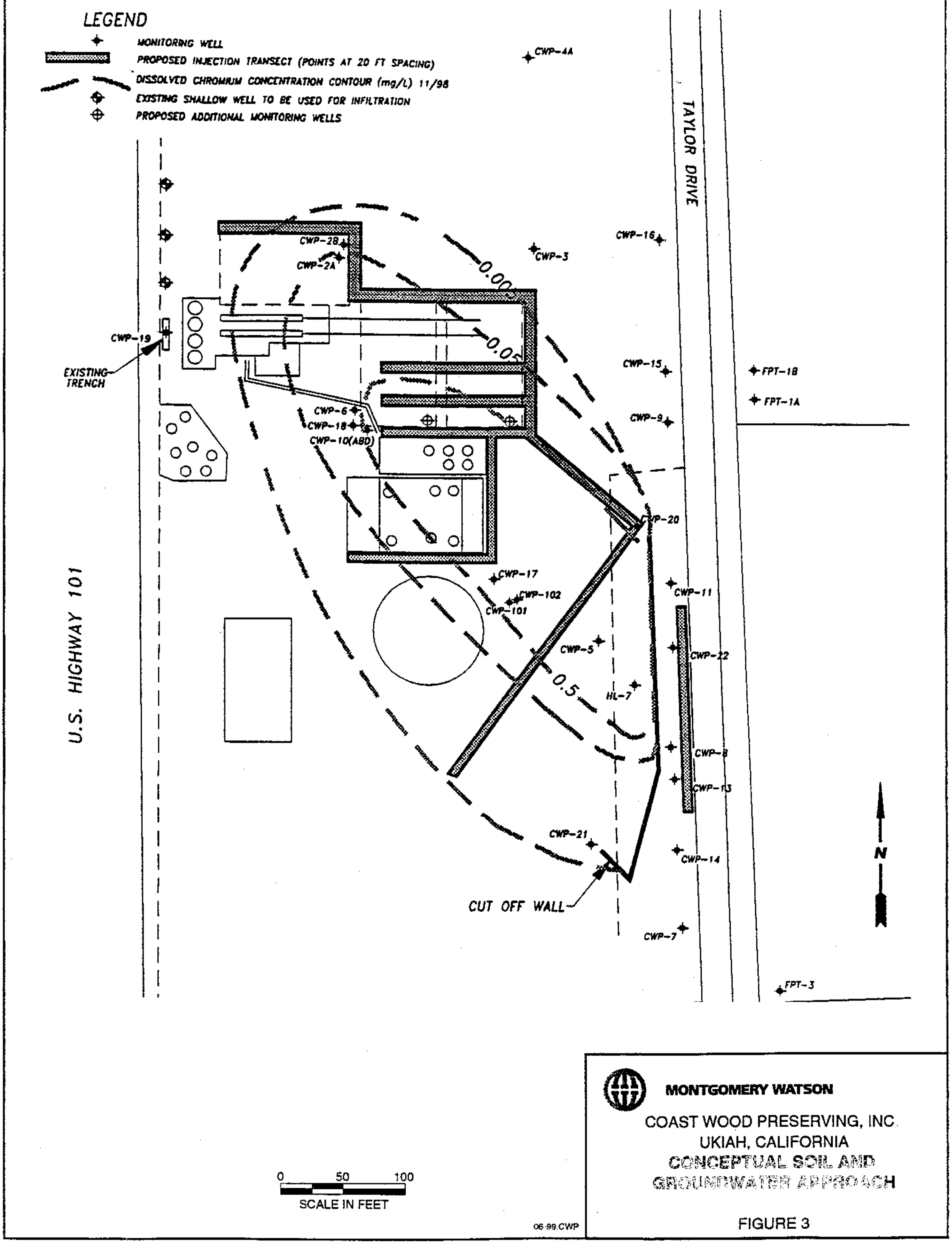
COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

EXTENT OF CHROMIUM IN SOIL AND SHALLOW GROUNDWATER

FIGURE 2



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COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA
CONCEPTUAL SOIL AND
GROUNDWATER APPROACH

FIGURE 3

Appendix A

Additional Information Regarding *In-Situ* Geochemical Fixation

Geochemical fixation application reduces costs and project life cycles for on-site treating plant chromium cleanup.

Treating The Treatment

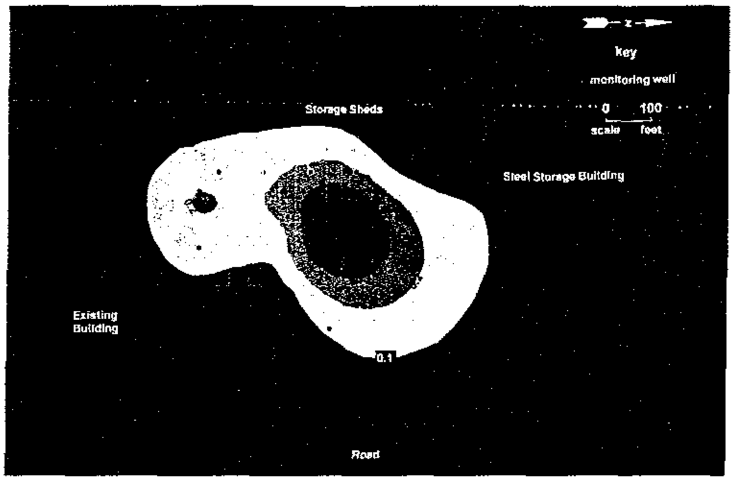

Figure 1: Hexavalent chromium groundwater concentrations prior to treatment

Chromium contamination is present at large numbers of wood treating facilities and many industrial sites throughout the U S. Nonetheless, few technologies exist which can effectively address this subsurface metals contamination within a reasonable cost or time frame.

Wood treating facilities impregnate acidic solutions of copper, chromium and arsenic into lumber to forestall rot and prevent damage from insects. Historically, releases have resulted from processing mishaps, handling accidents or from lumber which was not completely dry when exposed to rain These releases can leach down through unsaturated soils, ultimately impacting saturated soils beneath the water table.

The most widely used method to extract chromium and other metals from soil and groundwater involves the continuous pumping of groundwater Such pump-and-treat systems flush chromium from the soil, and treat the pumped groundwater at the surface, using standard metals-removal processes Treated water is reinjected upgradient of the aquifer or discharged under permit to a nearby stream or publicly owned treatment works.

The major shortcoming of the pump-and-treat approach is that massive amounts of groundwater—commonly 50 times the volume of the contaminated plume—must be pumped to adequately dislodge the metal contaminants from the soil. Such aggressive pumping lowers the water table, leaving chromium trapped in low-permeability layers such as clay stringers present in virtually all aquifers.

Trapped metals remain inaccessible to flushing until the water table has had a chance to return to normal levels (i e , once the pump has been turned off or as a result of seasonal fluctuations) Once the water table has returned to normal, these isolated metals often find their way back into groundwater, recontaminating a treated aquifer and prolonging the life of the remediation project

Geochemical Fixation

Geochemical fixation a new metals cleanup technology developed by Fluor Daniel GTI, is now available to minimize the threat posed by chromium and other metals in soil and groundwater. An improvement over the conventional pump- and-treat approach, geochemical fixation mixes chemical reagents with a smaller volume of pumped groundwater, and reinjects the treated water around the perimeter of a contaminated plume.

As the treated plug of groundwater moves through the plume, the reagent promotes subsurface reactions which cause dissolved metals to change chemical forms and bind or fix onto soil particles rendering them inert and immobile. This reduces the risk of environmental damage and human exposure by metals left in place, and substantially reduces the total volume of groundwater which must be pumped—typically calling for pumping just 10% of the total volume of groundwater otherwise extracted using conventional pump-and-treat methods

Reagents vary depending on soil characteristics such as pH, clay content, total organic carbon, iron and manganese oxide content and cation exchange capacity For anion-mobile metals such as hexavalent chromium and selenium, the reagents of choice are "reductants."

Accomplishing in months what would otherwise take years, geochemical fixation technology can be up to 90% faster and less expensive than conventional pump-and-treat methods for dealing with metals.

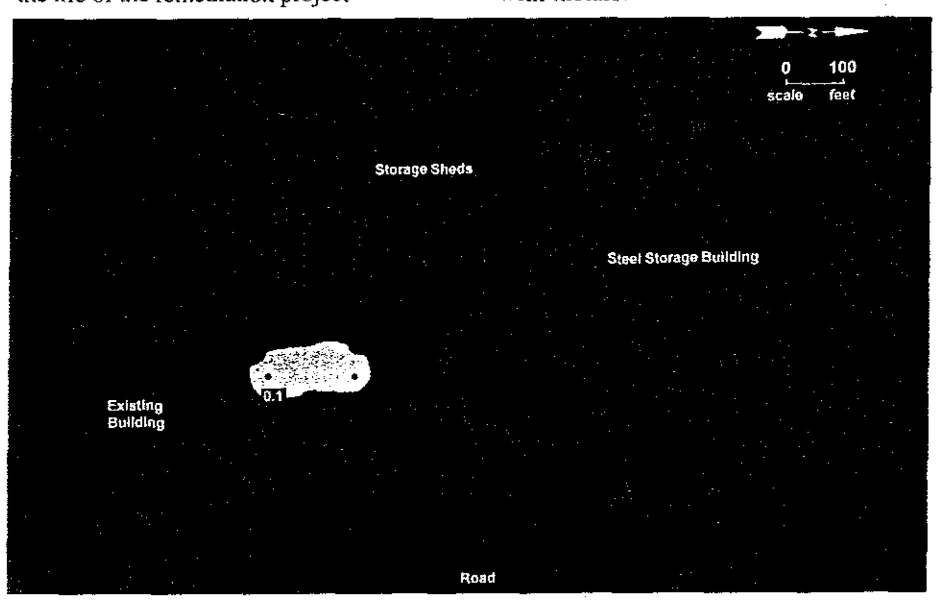

Figure 2: Hexavalent chromium groundwater concentrations following three months of geochemical fixation treatment

Case History

The owner of a Midwestern wood treatment plant was faced with the prospect of cleaning up multiple areas of soil and groundwater contaminated with hexavalent chromium, a byproduct of copper chromium arsenate solution (CCA) used to treat wood. With conventional pump and treat technologies, cleaning up this site could have taken more than 10 years at a cost of several million dollars.

With geochemical fixation, hexavalent chromium is quickly converted to trivalent chromium, which is stable, immobile and less toxic. Instead of years, unacceptable levels of chromium contamination and associated liabilities are cleaned up within weeks or months of initiating treatment.

On this environmentally sensitive site there were four plumes threatening domestic drinking wells downgradient from the site. One plume of contamination was close to the property's boundary. In two months, the hexavalent chromium in this critical zone was reduced to less than drinking water standards.

The basic method of treatment involved extracting and mixing groundwater with a reductant and reinjecting the treated water through upgradient soils and groundwater. This closed-loop approach rapidly dispersed reductant throughout the plume which transformed hexavalent chromium to its stable, immobile and less toxic form.

Two of the other plumes were created by storing treated wood on a non-covered asphalt pad. Water from rain or melting snow leached some of the treatment solution from the treated wood and migrated off the asphalt, creating a "halo" plume of contamination in soils surrounding the pad.

In one case, the run-off reached a retention pond, which became the source of chromium in groundwater. Although concentrations were below drinking water standards, the owner elected to treat groundwater anyway. This was accomplished by pumping groundwater from two nearby wells, mixing it with a reductant and recirculating it back into the pond. This closed-loop system distributed enough reductant into the groundwater to quickly reduce and render immobile the chromium contamination.

Another plume was more serious because concentrations were significantly higher. Three recovery wells were placed downgradient of the plume as close as possible to the property line. This created a recovery zone, which prevented contamination from migrating off-site. Water from these wells was mixed with a reductant and reinjected into the subsurface upgradient by way of six vertical injection wells.

After three months of treatment, chromium concentrations had been reduced significantly (See figures 1 and 2.)

Currently, Fluor Daniel GTI is addressing a fourth hot spot of chromium contamination on site. A series of five injection wells has been installed at the upgradient edge of the plume. These wells are given doses of concentrated reductant solution at two-week intervals. The reductant migrates downgradient where it is captured by one of the closed-loop treatment systems on the site. By piggy-backing this installation onto an existing treatment system Fluor Daniel GTI was able to significantly reduce engineering and constructions costs.

Fluor Daniel GTI began working on these projects in June 1995. Although it has been necessary to adapt to unexpected site conditions, completion of the chromium cleanup is expected in 1997 at a total cost of approximately $600,000. **TP**

The article was submitted by Flour Daniel GTI, Norwood, Mass. Contact Peggy Bliss at (617) 769-7600 or Linda DeSisto (401) 647-7578.

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PROCEEDINGS

Eighty-Sixth Annual Meeting

of the

AMERICAN WOOD-PRESERVERS' ASSOCIATION

Opryland Hotel, Nashville, Tennessee

April 30, 31, May 1, 2, 1990

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1990

In-Place Cleanup of Heavy Metal Contamination of Soil and Ground Water at Wood Preservation Sites

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INTRODUCTION

As noted by Hartford (1986) copper, chromium and arsenic (CCA) preservation solutions have emerged after over half a century of trials as an outstanding water-borne preservative. CCA formulation solutions undergo complex reactions during the treatment process in which the active ingredients are fixed in the wood without being rendered inactive. Similar fixation reactions occur when CCA solutions encounter natural earthen materials. It is important for wood preservation industry personnel to recognize that the degree of fixation of the various constituents of CCA solutions varies as a function of soil properties. It is also important to recognize that copper, chromium, and arsenic all have stringent environmental controls associated with their use and dispersal in the environment.

All three of the elements described above are covered by EPA Drinking Water Standards. Arsenic and chromium are limited by Primary Drinking Water Standards of 0.05 mg/liter each; copper has a Secondary Drinking Water Standard of 1 mg/liter. The relatively high copper standard is a recognition of the fact that copper is not toxic to humans in this concentration range; in fact it is an important trace element required for metabolism. By contrast, fresh and salt water aquatic life are severely affected by copper concentrations, as well as by concentrations of arsenic and chromium. For example, the Canadian fresh-water aquatic guideline for copper is a function of the hardness of the water but ranges from 2 to 6 micrograms/liter. This range is generally lower than the fresh water aquatic guidelines cited for both arsenic and chromium. The impact of the three elements varies depending on the organism and the uptake mechanism.

Dr. Henry S. Brown (1986) noted that essentially all soils, rocks, and water contain arsenic, chromium, and copper. He presented an excellent summary of the natural abundance of the three elements in surface materials and water. He also presented a discussion of their relative mobility, and concluded that arsenic and copper are generally twice as mobile as chromium in the environment. As noted by Rouse (1988), this conclusion is valid for the three elements in their natural valence state, but hexavalent chromium is much more mobile than either copper or arsenic. In the hexavalent state, chromium is not as readily attenuated under natural conditions. Rouse (1988) went on to note that natural mechanisms were available which could be used to achieve in-situ immobilization of chromium. The basis for these mechanisms is the conversion of the hexavalent chromium to the trivalent form, and the subsequent sorption of the reduced chromium on natural earthen materials. This paper presents further discussion of the approach utilized in such in-situ remediation, and offers the approach as a cost-effective alternative to more conventional remediation practices.

GEOCHEMICAL ATTENUATION

Numerous investigators have provided insight into the geochemical processes that are at work when acidic solutions containing dissolved inorganic constituents penetrate the subsurface. An excellent description of the ground-water mobility of various contaminants is provided by Cherry, Shepherd, and

Morin (February 1982). Another discussion of contaminant migration, as it relates to the phosphate industry, is provided by Rouse and Bromwell (March 1983).

Numerous investigations have been published for uranium, base metal, and precious metal operations throughout the United States and Australia (Rouse and Pyrih, 1983; Rouse, February 1981; Taylor and Antonmaria, November 1978; Wilson and Rouse, May 1980). The geochemical processes that work as acidic solutions come in contact with natural materials are extremely dynamic. Some of the reactions tend to remove contaminants, while others exchange one contaminant for another, or actually may add contaminants into the system. These dynamic processes must be understood before water-quality data can be correctly interpreted or effective remedial measures can be designed.

When acidic, metal-bearing solutions such as CCA treatment solutions enter natural soil or rock material, a complex series of geochemical reactions are initiated which act to retard or prevent the migration of contaminants. To understand the complex reactions and the resultant data, it is helpful to visualize a conceptual geochemical model such as the one described by Rouse and Pyrih, (September 1985). This conceptual geochemical model of contaminant migration and attenuation is briefly summarized below.

By far, the single most significant geochemical process that takes place between acidic seepage and natural earthen materials is the reaction and dissolution of carbonate minerals. Hydrogen ions in the acidic solution react with calcite ($CaC03$) or other carbonate minerals which may be present in the underlying soil, sediment or bedrock. In the course of the reaction, hydrogen ions are consumed to neutralize the acidity of the seepage.

Neutralization of an acidic seepage establishes pH conditions which are favorable to the functioning of geochemical mechanisms such as ion exchange, sorption, and precipitation. Precipitation of heavy-metal hydroxides is one mechanism which can be initiated by calcite dissolution and acid neutralization. Metal precipitation is pH dependent and results in the sequential removal of metals as a function of increasing pH. Iron is the earliest common metal hydroxide to be precipitated, followed in turn by aluminum, copper, zinc and finally manganese. Other metals and trace elements are co-precipitated along with the metal hydroxide on aquifer grain coatings. As an acidic waste percolates into the subsurface, geochemical processes begin to occur as a reaction front advances. Depending upon the calcite content of the natural subsurface material, the acid front is retarded in its down-gradient movement relative to the rate of fluid advance. The advance of the acid front is controlled by the number of pore volumes of acid water that will react with a given volume of porous media to dissolve all the calcite.

As the contaminant plume migrates down gradient, a total of three distinct zones develop (Figure 1). The first zone, which may be termed the "core" zone, consists of ground water with a quality which is virtually identical to that of the source of the seepage. The water is characterized by extremely low pH, very high dissolved solids concentrations, and high concentrations of heavy metals. In the case of CCA solutions, high concentrations of copper, chromium, and arsenic would be expected to be present in fluid of the core zone. In the core zone, virtually all the carbonate minerals in the soil or bedrock have been removed by chemical reaction.

The second zone in the conceptual model is termed the "active" zone, and is the area of active calcite dissolution and the formation of chemical precipitates including gypsum and metal hydroxides. Water in this zone is characterized by high levels of some dissolved metals, in accordance with the sequence of heavy metal hydroxide removal. Arsenic and copper are generally removed within the active zone, in response to the formation of metal oxide coatings and coprecipitates.

The down gradient of the three zones has been termed the "neutralized" zone. Water in this zone is characterized by high concentrations of total dissolved solids, and is frequently saturated with respect to gypsum. Very low concentrations of arsenic and copper would generally be present within the neutralized zone.

For any conceptual model, there are certain exceptions to the rule. Unfortunately for the wood treating industry, hexavalent chromium is the exception. Experience has shown that hexavalent chromium is very "conservative" in soil and groundwater environments, that is to say that the chromium moves at the same rate as the ground water and is not attenuated to any significant extent by naturally-occurring geochemical reactions.

Chromium has a unique geochemical behavior in natural water systems. Chromium is amphoteric in nature and is soluble in water in both anionic and cationic forms. Trivalent chromium is the most common form of naturally-occurring chromium, but is largely immobile in the natural environment, with natural waters having only traces of chromium unless the pH is extremely low. Under strongly oxidizing conditions, chromium is present in the hexavalent state, and persist in anionic form as chromate. Natural chromates are rare; however, the use of hexavalent chromium in CCA solutions can introduce high concentrations of oxidized chromium.

Typically, chromium in the reduced form is sparingly soluble but shows virtually limitless solubility

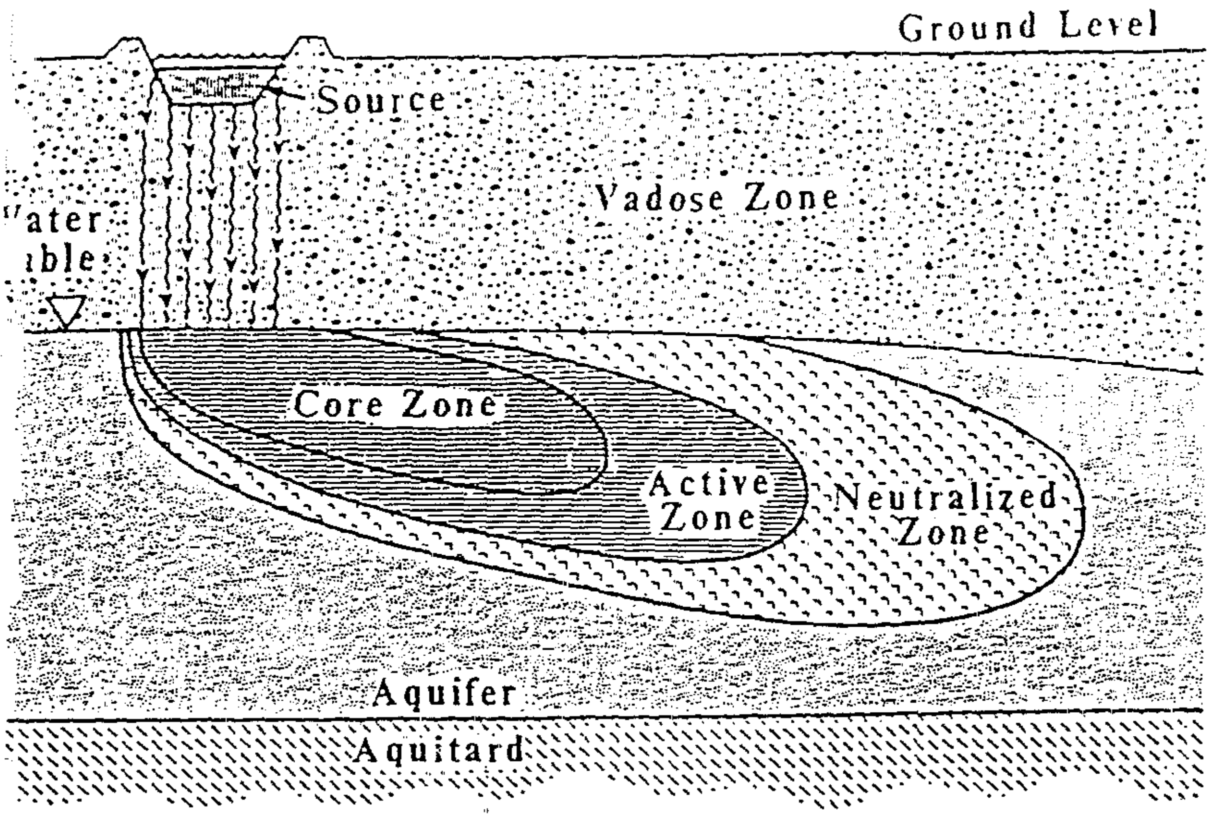

Figure 1. **Conceptual Geochemical Model of Zones in a Contaminant Plume**

in the oxidized chromate form. This behavior is very similar to the geochemical behavior of uranium, which is readily soluble in the oxidized (+6) form and insoluble in the reduced (+3) form. Such geochemical behavior has previously been used to advantage in uranium leach mining. Similar geochemical behavior of chromium has the potential for being used to advantage in remediation of soil and ground-water contamination by hexavalent chromium.

Cleanup of chromate can be achieved in place (below the land surface) by introducing a chemical reagent capable of reducing hexavalent chromium to the trivalent state, and allowing the trivalent chromium to geochemically react with natural soil of sediment material. If the geochemical properties of the sediment are favorable for this interaction, the trivalent chromium will be "fixed" and immobilized in geochemical traps in the subsurface. It is possible to predict the behavior of the trivalent chromium by evaluation of a range of sediment properties which facilitate this interaction.

PRACTICAL IN-PLACE REMEDIATION

Experience gained from the remediation of in-situ uranium leaching operations has been utilized to develop a phased approach for evaluating the feasibility of in-situ remediation of copper, chromium, and arsenic contamination of soil or ground water. As was noted above, copper and arsenic mobility is largely controlled by the pH of the migrating solutions. Thus, it is possible to achieve in-situ remediation of copper and arsenic by modification to the pH regime, so long as other conditions such as redox conditions are maintained within an appropriate range. In some cases, it may be necessary to form a co-precipitate of ferric oxyhydroxides and ferric arsenates, where the natural subsurface materials do not have adequate geochemical sorptive capacity.

The author's experience has been that it is best to utilize a phased evaluation of the feasibility of in-place chromium remediation. In the first phase, natural earthen materials are analyzed for certain geochemical properties which experience has shown

limit the mobility of trivalent chromium. These properties include acid and base neutralizing potential, iron and manganese hydrous-oxide content, total organic carbon, cation exchange capacity and exchangeable cations. Based on the result of these analyses, a preliminary decision is made whether the site would be suitable for geochemical remediation under near-ambient conditions of whether significant geochemical modifications would be necessary.

Subsequent to the evaluation of the geochemical properties, a series of laboratory testwork utilizing the sequential batch test and the column test approach are usually required to define the degree of chromium mobility at a particular sift. Figure 2 presents results of three paired column experiments utilizing actual chromium-contaminated aquifer material from a wood-treating facility in the Central Valley of California. In each of the pairs of curves, the upper curve represents the ambient chromium concentration using the clean-water sweep approach. The lower curve reflects duplicate test wherein an innocuous reagent was added in order to reduce the hexavalent chromium to the trivalent form, which in turn was immobilized by geochemical interaction with the aquifer material.

Upon completion of the laboratory evaluations described above, an actual field pilot-scale test must be conducted. Typical field tests most commonly use the "push-pull" approach. The purpose of the push-pull field test is to evaluate restoration feasibility under field conditions having significant vertical variability.

In the typical push-pull procedure, an actual contaminated well within the hexavalent chromium ground-water plume is selected and is pumped in order to withdraw a finite, measured quantity of contaminated water. The chromium-contaminated water is then treated for chromium removal, excess reagent added to the water, and the water is adjusted to optimal geochemical conditions in order to promote chromium fixation in the subsurface. The clarified, treated water is then decanted back down the production well, forming a cylinder of contaminant-free water immediately adjacent to the well bore. After the water equilibriates with the aquifer material, the well is again pumped in order to withdraw a measured quantity of water. This pump discharge is sampled for chromium concentration as a function of pumpage volume. If the addition of the reducing agent is effective at establishing favorable geochemical conditions for fixation of chromium in-place, breakthrough of contaminant levels is retarded relative to that anticipated under plug-flow contaminant migration conditions. The amount of retardation is a measure of the in-place effectiveness.

Upon completion of the laboratory and field testwork described above, the various regulatory agencies can be approached with the data to allow permitting of the in-situ remediation approach. These data are necessary prior to actual permitting under the EPA Underground Injection Control regulations. The reagents utilized in the in-situ approach are innocuous, and the injected water would meet drinking water standards prior to reinjection.

ANTICIPATED ECONOMIC AND ENVIRONMENTAL ADVANTAGES

Capital costs for in-place cleanup of contamination by means of geochemical attenuation are generally equivalent to the capital costs for cleanup by means of the "clean-water sweep" approach. Capital costs associated with recovery wells and surface treatment systems are common to both techniques. The in-place remediation equipment is often slightly less expensive since it does not have to operate for as long as does the equipment required in pump and treat options. This saving is offset by the need for reinjection wells and/or pits required for in-place remediation. Monitoring costs for in-place remediation are also more expensive; however, the monitoring program need not be operated for as long as in the case of conventional techniques.

The major cost saving of in-place remediation, relative to conventional techniques, comes in the area of operating cost. Such costs are directly related to the volume of water which must be pumped under each technique. For cost comparison purposes, it is assumed that in-place remediation of a plume requires withdrawal of 5 pore volumes and the clean-water sweep approach requires pumpage of 30 pore volumes, or 6 times as much pumpage. While each site has different requirements associated with the geochemistry, experience has shown the ration commonly is higher, to values up to 20.

Since treatment costs are directly related to pumpage requirements, it is obvious that in-place methods enjoy a significant economic advantage over operating costs for conventional techniques. Using the ration of 6 mentioned above, and a treatment cost of \$.50 per 1,000 gallons, a plume 500 ft. wide by 2,000 ft. long by 200 ft. thick (200,000,000 cu. ft. or 1,500,000,000 gallons) would have treatment costs of \$125,000 for in-situ remediation and \$750,000 for conventional treatment. The significant cost saving of in-place remediation is evident.

In-place remediation also has significant environmental advantages over conventional techniques. As described above, in-place techniques involve much less pumping and subsequent surface discharge, an advantage in areas of water scarcity. Much less treatment is required, which results in less treatment-plant sludge for disposal. In the case of chromium

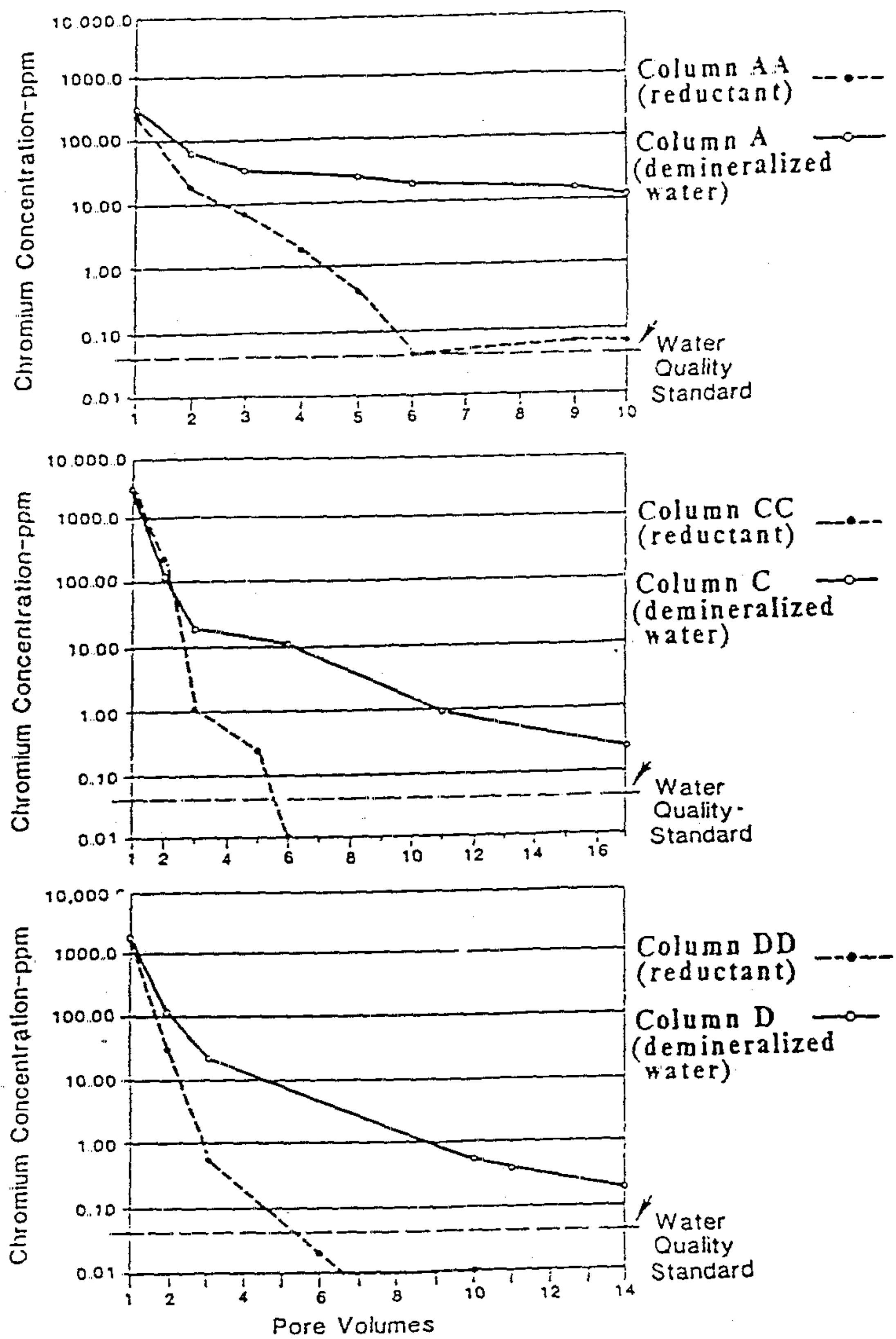

Figure 2. Chromium Concentration in Paired Column Effluents as a Function of Pore Volume Throughout.

treatment, the sludge must be disposed into secure landfills, which are under increasing demand for receiving waste. Disposal costs are again directly related to sludge production. Sludge disposal also carries a significant future liability which can be directly related to the quantity of material disposed.

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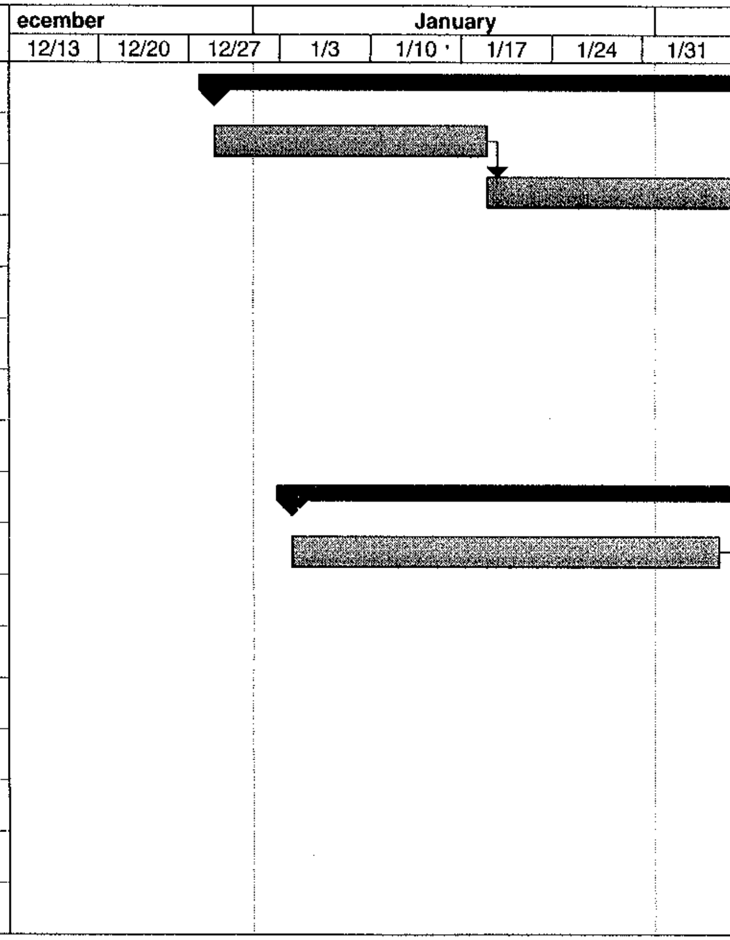
Appendix B

Schedule

RAP Amendment Schedule
Coast Wood Preserving, Ukiah, CA

ID	Task Name	Start	Finish
1	**RAP AMENDMENT**	Tue 12/29/98	Wed 7/7/99
2	CWP Drafts RAP Amendment	Tue 12/29/98	Mon 1/18/99
3	CalEPA/RWQCB Review Draft RAP Amendment	Tue 1/19/99	Mon 5/10/99
4	CWP addresses CalEPA/RWQCB Comments	Thu 5/13/99	Wed 5/19/99
5	Cal EPA/RWQCB review revised RAP Amendment	Thu 5/20/99	Wed 6/2/99
6	CWP Finalize Rap Amendment for Public Comment	Thu 6/3/99	Fri 6/4/99
7	Public Comment	Mon 6/7/99	Tue 7/6/99
8	CalEPA/RWQCB Approves RAP Amendment	Wed 7/7/99	Wed 7/7/99
9	**REMEDIAL DESIGN**	Mon 1/4/99	Fri 7/23/99
10	CWP Prepares Draft RD	Mon 1/4/99	Fri 2/5/99
11	CalEPA/RWQCB Review	Tue 2/9/99	Thu 7/15/99
12	RWQCB drafts revised WDR	Tue 2/9/99	Fri 6/4/99
13	RWQCB Approves Revised WDR (July Board Meeting)	Thu 7/22/99	Thu 7/22/99
14	CWP addresses Comments on Draft RD	Fri 7/16/99	Thu 7/22/99
15	CalEPA/RWQCB Approves RD	Fri 7/23/99	Fri 7/23/99
16	**IN SITU REMEDITATION**	Wed 9/1/99	Wed 9/1/99
17	In Situ Remediation Commences As Described in the RD	Wed 9/1/99	Wed 9/1/99



Project: coast
Date: Wed 6/2/99

Task	Rolled Up Task	Project Summary	
Progress	Rolled Up Milestone	Split	
Milestone	Rolled Up Progress	Rolled Up Split	
Summary	External Tasks		

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Coast Wood Preserving, Ukiah, CA

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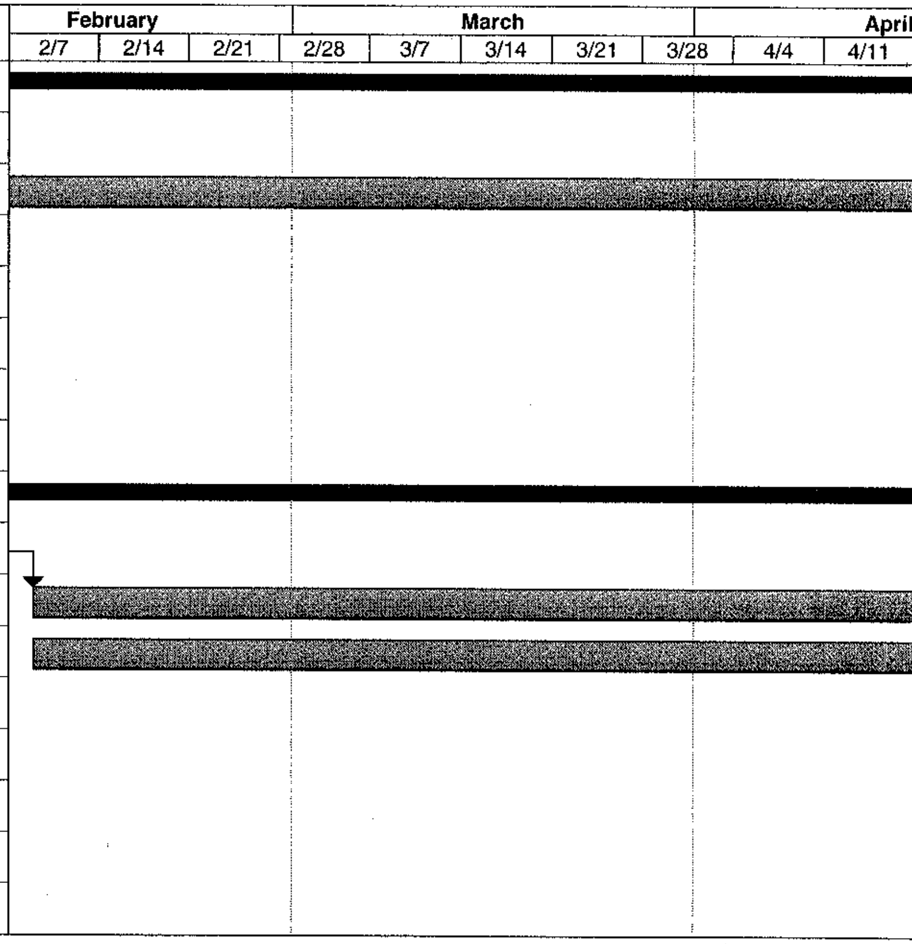

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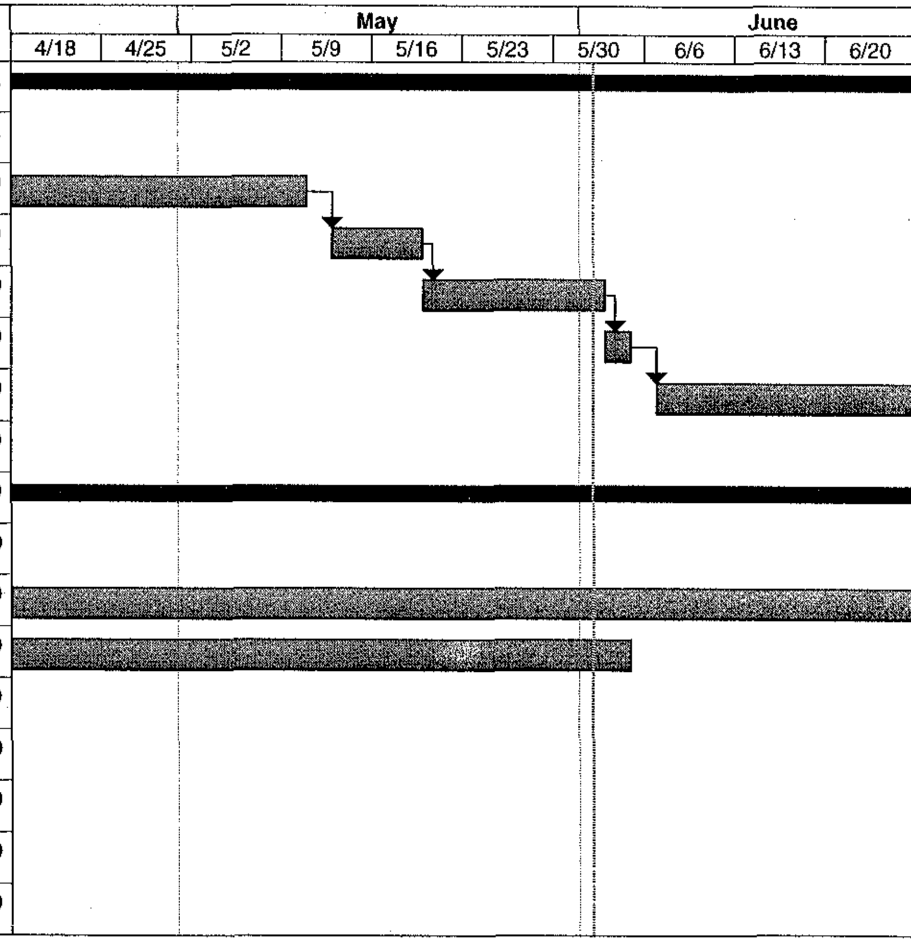

Project: coast
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Task
Progress
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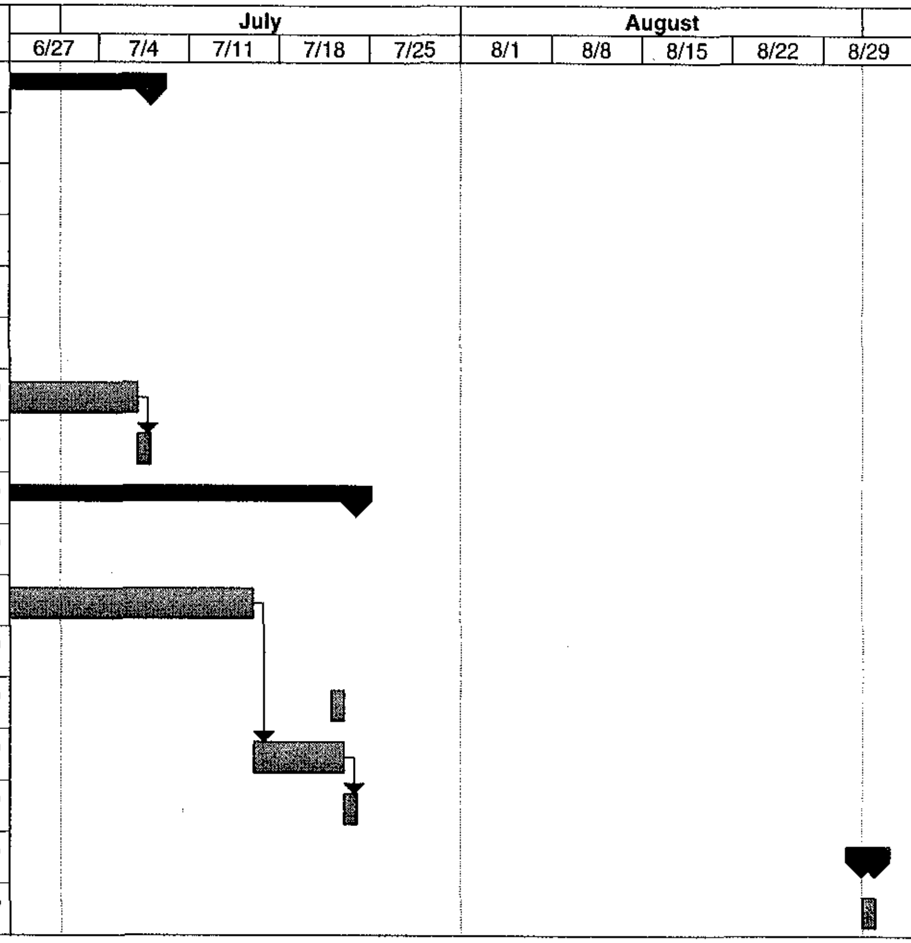

Project: coast
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Task	Rolled Up Task
Progress	Rolled Up Milestone
Milestone	Rolled Up Progress
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Project Summary	
Split	
Rolled Up Split	

Fact Sheet
August 2003

EXPLANATION OF SIGNIFICANT DIFFERENCES FOR THE REMEDIAL ACTION PLAN, COAST WOOD PRESERVING SITE
Ukiah, California

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

DTSC is one of six Boards and Departments within the California Environmental Protection Agency. The Department's mission is to restore, protect and enhance the environment, to ensure public health, environmental quality and economic vitality, by regulating hazardous waste, conducting and overseeing cleanups, and developing and promoting pollution prevention.

State of California

California Environmental Protection Agency

INTRODUCTION

The California Environmental Protection Agency, **Department of Toxic Substances Control (DTSC)** is issuing this fact sheet to inform the community about significant changes to the **Remedial Action Plan (RAP)** for the **Coast Wood Preserving Site** (Site). **DTSC** approved the **RAP** in September 1989 and a **RAP** Amendment in July 1999. The changes to the **RAP** include revision of the soil cleanup levels and modification of the scope and timing of soil cleanup. Additionally, this fact sheet satisfies requirements in Federal law that an **Explanation of Significant Differences (ESD)** be published by a lead agency when significant changes in the scope, performance, or cost of cleanup actions adopted in a remedy selection document occur, but do not fundamentally alter the selected remedy. This **ESD** will become part of the Administrative Record for the cleanup decision of the Site.

DTSC has been the lead agency overseeing the investigation and cleanup of hazardous substances releases at the Site. The **U.S. Environmental Protection Agency (U.S. EPA)**, Region IX listed the Site on the National Priorities List in 1983 and continues to work with **DTSC** as a support agency, along with the **California Regional Water Quality Control Board, North Coast Region (RWQCB)**.

The **RAP** primarily documented the inclusion of interim measures, designed to prevent migration of ground-water contamination, as part of the Site remedy. Additional measures, involving ***in-situ* reduction and fixation** of **hexavalent chromium**, were incorporated as part of the remedy through the **RAP** Amendment and have resulted in a significant decrease in the level of ground-water contamination. The **RAP** anticipated that soil cleanup would not be undertaken until the cessation of wood-preservation activities at the Site, but **Coast Wood Preserving Inc. (CWP)** has proposed that some accessible contaminated soil can be remediated while the plant is operational.

The **RAP** established soil cleanup goals for **arsenic** and total **chromium** of 15 **mg/kg** and 100 **mg/kg**, respectively. Limited background soil sampling was used as the basis for setting these cleanup levels. This **ESD** documents the establishment of risk-based soil cleanup levels for **arsenic** and **hexavalent chromium**. The **arsenic** goal is based on a commercial / industrial setting with on-site workers and on a health risk of 10^{-5}. The cleanup goal for hexavalent **chromium** in soil is based on

preventing exceedance of the California Maximum Contaminant Level (MCL) in ground-water through the potential leaching of **chromium** from soil. Additionally, the **ESD** documents the change in the timing of the soil cleanup and how soil cleanup will be conducted. A more detailed discussion of the specific changes that are being made to the **RAP** is presented in the "Basis For and Description of Significant Differences" section of this Fact Sheet.

SITE HISTORY AND CONTAMINATION

CWP has operated a wood-preserving facility at the intersection of Taylor and Plant Roads in Ukiah, California, since 1971. **CWP** has used wood-preserving solutions containing **copper**, **chromium**, and **arsenic**. In January 1972, concerns were raised by Mendocino County and California Department of Fish and Game personnel about the possible discharge of preserving solutions from the Site *via* runoff of rainwater into the Russian River. **RWQCB** issued **CWP** orders in 1972 to implement measures to keep the preserving solutions contained on the Site. **CWP** complied with the orders by paving the Site and constructing a slurry wall to contain the **chromium**-impacted ground-water. Between 1981 and 1984, a series of investigations were conducted by **CWP**'s consultants to investigate the release of preserving solutions to soil and ground-water. Based on the investigation data, a **RAP** was prepared and approved by **DTSC** on September 29, 1989. A Covenant and Agreement was filed with the Mendocino County Recorder on November 29, 1989 to restrict the use of the property to industrial use only.

CWP subsequently submitted a "Proposed Amendment to the Remedial Action Plan" (Montgomery Watson, May 1999), which proposed enhancements to the remedial program for ground-water contamination at the site, utilizing an innovative ***in-situ* reduction and fixation** approach. Under the Amendment, chemical reductant solution was injected through a grid of injection points, under pressure, to react with the mobile **hexavalent chromium** and reduce it to the low-solubility **trivalent** form of **chromium**, the form in which **chromium** naturally occurs. This **RAP** amendment was approved by **DTSC** in July 1999.

SELECTED REMEDY

The **RAP** approved by **DTSC** in September 29, 1989 primarily focused on the prevention of further contamination of surface runoff and the containment of ground-water contamination. The **RAP** included the following components:

- Surface runoff management,
- Control of contaminated soil,
- Ground-water contamination control and remediation by pumping,
- Electrochemical treatment of pumped ground-water,
- Treated water recycling/discharge to the Ukiah Sewage Treatment Plant or reinjection on site, and
- Surface water and ground-water monitoring.

A qualitative risk assessment contained in the **RAP** concluded that because of the surface paving there was no direct exposure to soil contamination and assumed that soil remediation would be conducted upon cessation of wood-preservation activities at the Site. The assumed method of remediation was to be on-site treatment of the contaminated soil containing 100 milligrams per kilogram **(mg/kg)** total **chromium** and 15 **mg/kg arsenic**.

The Amendment to the **RAP** centered on the treatment of ground-water contamination by the high-pressure injection of reductant solution on a grid basis, through a series of temporary injection points. These points of injection were withdrawn

and sealed upon injection of the reductant. When possible, the injections were conducted during periods of high ground-water levels, to allow for contact of reductant solution with **hexavalent chromium** contained in fluids in the normally unsaturated soil in the zone of ground-water fluctuation. The Amendment also proposed installing infiltration galleries in the areas with high soil **chromium** concentration. These galleries would be constructed by trenching to about 3 feet below ground surface, backfilling the trenches with permeable material, and infiltrating reductance into the vandose zone. The **RAP** amendment also recognizes that it is technically impractical to install these infiltration galleries into the active operations areas such as in the existing treatment cylinders or building structures.

BASIS FOR DESCRIPTION OF SIGNIFICANT DIFFERENCES

Cleanup Goals

The **RAP** established soil cleanup goals for **arsenic** and total **chromium** of 15 **mg/kg** and 100 **mg/kg**, respectively. Limited background soil sampling was used as the basis for setting these cleanup levels. Risk-based soil cleanup levels were developed as part of a risk-based site assessment commissioned by **CWP**. As a result, a "Risk-Based Cleanup Level Development Report" (Montgomery Watson Harza, February 19, 2002) was prepared in consultation with toxicological personnel of **DTSC**, utilizing recent soil sampling data and changes in risk assessment methodology made since the date of the **RAP** preparation. **DTSC** subsequently approved soil cleanup goals of 27 **mg/kg** for **arsenic** and 42 **mg/kg** for **hexavalent chromium**, in a letter dated March 27, 2002. The **arsenic** goal is based on a commercial / industrial setting with on-site workers and on a health risk of 10^{-5}. The **hexavalent chromium** goal is based on preventing exceedance of the MCL in ground-water through the potential leaching of **chromium** from soil. These cleanup goals will be utilized in the remediation of accessible soil during plant operation. They will also be the controlling values for the future remediation of that portion of the soil not now accessible for remediation, for example the soil under the treatment cylinders and regulatory E.P.A. Subpart W drip pad. Drip pad regulations are contained in 40 CFR 265.440, Appendix C.

Arsenic- **Arsenic** is a widely occurring (twentieth most common element) metalloid with highly variable geochemical behavior, depending on the valence state in which it occurs. Because of the geochemical behavior of **arsenic**, the goal was established on the basis of the total concentration. Under oxidized conditions, **arsenic** occurs in the pentavalent form as a complex **oxy-anion**, and reacts with ferric iron to form a low-solubility ferric hydroxide / ferric arsenate precipitate. The absence of dissolved **arsenic** in ground-water in the immediate proximity to elevated soil concentrations of **arsenic** at areas such as near monitor well **CWP**-114 is an indication that much of the **arsenic** present in the soil is in the form of such low-solubility material. Under highly reduced conditions, **arsenic** reacts with iron and sulfur to form sulfide minerals such as arsenopyrite. Under slightly reduced conditions, **arsenic** becomes soluble as the **oxy-anion** arsenite. Such behavior has been noted during the **in-situ reduction** of **hexavalent chromium** in the on-going ground-water remediation at the site, but is expected to be a temporary condition.

The "Risk-Based Cleanup Level Development Report" (Montgomery Watson Harza, February 19, 2002) follows regulatory protocols and provides the justification for considering a site-specific, health-protective, risk-based cleanup goal. The cleanup goal for **arsenic** of 27 **mg/kg** differs from the previously established background value of 15 **mg/kg**, in that it is based on a quantitative evaluation of potential human health risks as summarized below. Consistent with the deed restriction placed on the Site in 1989, the risk evaluation assumes exposures to and develops a health-protective risk-based **arsenic** cleanup level

for current and future on-site commercial/industrial workers. The deed restriction limits include:

- Restrictions from development of hospitals, schools, day-care centers, and residential use;
- Maintenance of a asphalt or concrete cap over the property; and
- Restrictions on any proposed earth work or other activities that may disturb the cap (e.g. DTSC notification, dust control, handling of materials pursuant to hazardous waste regulations).

The cleanup goal for **arsenic** of 27 **mg/kg** conservatively assumes direct contact with site soils, even though the deed restriction requiring surface paving will protect against direct exposures. The **arsenic** cleanup goal of 27 **mg/kg** is below 440 **mg/kg** corresponding to a Health Index of 1 for on-site workers that would be protective of non-cancer health effects. The **arsenic** cleanup goal is also within the range of 2.7 – 270 **mg/kg** that would be protective of the 10^{-6} to 10^{-4} acceptable cancer risk range.

Chromium- Chromium is also highly variable in its behavior in the subsurface, depending on the valence state in which it occurs. Naturally occurring **chromium** is in the reduced **trivalent** state, and is known as a trace element needed for life. **Hexavalent chromium** is a toxic **oxy-anion**, which is highly mobile under normal geochemical regimes. The prior **in-situ reduction** efforts in the ground-water at the Site have demonstrated the ability to reduce the **hexavalent chromium** to the **trivalent** form by the addition of ferrous iron or reduced sulfur reagents. The cleanup goal is for the mobile, toxic **hexavalent** form of **chromium**, in contrast to the original goal of 100 **mg/kg** total **chromium**, which failed to distinguish between the toxic and non-toxic forms of the element.

Remedial Timing

As previously noted, the **RAP** did not anticipate remediation of soil contamination until closure of the **CWP** facility. However, **CWP** has proposed to **DTSC** that soil remediation be performed in those portions of the plant which are accessible, while the plant is operational, rather than waiting until the end of plant operation. Soil remediation would be conducted by **CWP** personnel and contractors, trained for such activities, as appropriate, with oversight from Montgomery Watson Harza (**MWH**) personnel. In this way, the remediation can proceed in a more timely fashion, while **CWP** personnel are available to aid in the efforts. It would also help reduce further contamination of ground-water that could occur when the water table rises to a high level.

Soil sampling, to a depth of 4 feet, was conducted within accessible areas south of the wood treatment facility during December, 2002 and January, 2003, in accordance with a DTSC-approved work plan. Laboratory results were used to define areas requiring deeper soil sampling, which was conducted during March, 2003. The results were then presented in a June 18, 2003 **MWH** report "Results of Accessible Soil Sampling for **Chromium** and **Arsenic** Contamination at the Coast Wood Preserving Facility, Ukiah, CA" and will be used in planning soil remediation. A remedial design work plan was submitted to DTSC in July, 2003, and soil remediation will be conducted beginning in the summer of 2003 and will be completed prior to the onset of the autumn rainy season, to allow for pavement replacement before runoff is likely to occur.

Changes to Remedial Actions

Results of soil sampling indicate that there are only two 10-foot by 10-foot areas (in the overall area where soil remediation is to occur) that are solely contaminated with **hexavalent chromium** over the cleanup goal, and further indicate that there is very little soil above the **hexavalent chromium** cleanup goal. Therefore, the soil cleanup is largely being driven by soil that exceeds the total **arsenic** concentration goal.

The soil cleanup for **arsenic** is based on total **arsenic** concentration, and hence cannot be remediated by use of **in-situ** techniques, which change the valence state, and mobility of the **arsenic**. Rather, soil contaminated with **arsenic** will be remediated by excavation and disposal offsite at a permitted facility. It is recognized that the presence of **hexavalent chromium** residual in the interstitial moisture has the opportunity to migrate to the ground-water, even though it is below the **hexavalent chromium** cleanup goal. To further minimize such potential migration, the bottom of the excavated areas will be treated with calcium polysulfide reductant, the same reagent previously used in the **in-situ** remediation of the ground-water, to convert a portion of the **hexavalent chromium** to the immobile **trivalent** form.

The proposed change is not expected to result in a significant change in the total cost of remediation, since it merely involves a change in timing of the remediation effort, from after plant closure to while the plant is still in operation. It does allow the remediation to be achieved while plant personnel are still on site, thereby somewhat reducing the needed supervision and oversight, but this is countered by increased costs mandated by working around on-going plant activities. The proposed change in the cleanup levels would remove about 1,100 cubic yards of soil in the accessible areas while the Site is still operational. The remainder of the soil contamination would be remediated when the Site ceases its operations.

Considering the changes that will be made to the selected remedy, DTSC believes the remedy becomes more protective of human health and the environment, complies with Federal, state, and local requirements that are applicable or relevant and appropriate to this remedial action, and is cost effective. Soil remediation in the accessible areas of the plant while it is in operation not only reduces exposure to site workers, but also reduces the potential for erosion into surface water and leaching into underlying ground-water, by infiltration and/or fluctuations in the ground-water level.

ESD REFERENCES

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Montgomery Watson, June 4, 1999, "Final Proposed RAP Amendment, Coast Wood Preserving, Ukiah CA", Prepared for Coast Wood Preserving

Montgomery Watson, January 12, 2001, "Combined 2000 Fourth Quarter and Annual Report and One-Year Review of *In-Situ* Chromium Reduction at the Coast Wood Preserving Site, Ukiah, California"

Montgomery Watson, January 15, 2001, "Coast Wood Preserving Second Five-Year Review", Prepared for Coast Wood Preserving

Montgomery Watson Harza, February 19, 2002, "Risk-Based Cleanup Level Development Report", Prepared for Coast Wood Preserving

Montgomery Watson Harza, June 18, 2003, "Results of Accessible Soil Sampling for Chromium and Arsenic Contamination at the Coast Wood Preserving Facility, Ukiah, California", Prepared for Coast Wood Preserving

GLOSSARY

Anions- Negatively charged ions. These may be simple one-element ions such as chloride or complex oxy-anions such as chromate or sulfate

Arsenic- Chemical element (symbol As) with Atomic Number 33. It frequently reacts with oxygen to form complex oxy-anions arsenite or arsenate.

Atomic Number- The charge on the nucleus of an atom.

Cations- Positively charged ions, usually a metallic element such as copper.

Chromium- Chemical element (symbol Cr) with Atomic Number 24. The hexavalent form reacts with oxygen to form complex oxy-anions chromate or dichromate. The trivalent form reacts with hydroxide ion to form chromium hydroxide solids.

Copper- Chemical element (symbol Cu) with Atomic Number 24. Commonly occurs as a cation.

CWP- Coast Wood Preserving, Inc.

DTSC- California Environmental Protection Agency, Department of Toxic Substances Control.

Elements- Substances in which all the atoms have the same positive charge on the nucleus. Examples include oxygen, sulfur, chromium, and arsenic.

EPA- United States Environmental Protection Agency.

ESD- Explanation of Significant Differences.

Fixation- A number of processes, such as adsorption, which tend to immobilize chemicals.

Hexavalent- Having a charge of six on an ion. Chromium is hexavalent in the oxy-anion chromate, and sulfur is hexavalent in the oxy-anion sulfate.

In Situ- Activities which occur in place, without excavation or other removal of soil.

Ions- Charged particles consisting of elements or combinations of elements.

Mg/kg- Milligrams per kilogram, a unit of concentration used for solid samples. It is equal to parts per million.

MWH- MWH, Inc, a consulting firm formed by the merger of Montgomery Watson, Inc and Harza Engineering. A consultant to CWP and developer of the *in-situ* remediation process.

Oxy-anion- a complex anion formed by the combination of a cationic element such as chromium and oxygen as a negatively charged particle. The chromate oxy-anion has the formula $(CrO_4)^{-2}$.

RAP- Remedial Action Plan.

Reduction- A chemical reaction involving the gaining of electrons. In the reduction of hexavalent chromium to the trivalent form, the chromium gains three electrons per atom.

RWQCB- Regional Water Quality Control Board, State of California.

Trivalent- Having a charge of three on an ion. Chromium is a trivalent cation in the naturally-occurring chromium hydroxide.

Anuncio

Si prefiere hablar con alguien en español acerca de ésta información, favor de llamar a Jacinto Soto, Departamento de Control de Substancias Tóxicas. El número de teléfono es (510) 540-3842.

For More Information

If you would like more information about the Site, please call Patrick Lee, at (510) 540-3847 or Rachelle Maricq, DTSC Public Participation Specialist, at (510) 540-3910.

Information Repositories

This ESD and the negative declaration, which are part of the Administrative Record for the site, as well as other documents relating to the Site are available for public review at the following locations:

DTSC File Room
700 Heinz Avenue
Berkeley, CA 94710
(510) 540-3800

Mendocino County Library
105 N. Main Street
Ukiah, California 95482
(707) 746-4491

Notice to Hearing Impaired Individuals

TDD users can obtain additional information about the Site by using the California State Relay Service (1-888-877-5378) to reach PPS at (510) 540-3910.

Rachelle Maricq
Department of Toxic Substances Control
700 Heinz Avenue
Berkeley, California 94710-2721

APPENDIX F

Remedial Cost Estimate and Cover Letter

Department of Toxic Substances Control

Matthew Rodriquez
Secretary for
Environmental Protection

Barbara A. Lee, Director
700 Heinz Avenue
Berkeley, California 94710-2721

Edmund G. Brown Jr.
Governor

June 29, 2016

Gene Pietila
Coast Wood Preserving, Inc.
P.O. Box 673
Ukiah, California 94582
info@wetreatwood.com

2016 TRI-ANNUAL REVIEW OF REMEDIAL ACTION COST, COAST WOOD PRESERVING, UKIAH, CALIFORNIA

Dear Mr. Pietila:

The Department of Toxic Substances Control (DTSC) Cost Estimating Work Group (CEWG) engineering staff has reviewed the 2016 Remedial Cost Estimate. The 2006 Consent Decree *CV-F-96-6055 AWILJO* requires Coast Wood Preserving to submit a Remedial Cost Estimate every three years. The last Remedial Cost Estimate was accepted in February 2016. The Remedial Action Order *HAS 88/89-015, Section 5.10 Financial Assurance*, requires that Coast Wood Preserving provide Financial Assurance sufficient to fund all costs associated with the approved Remedial Action Plan. The 2016 Remedial Cost Estimate identifies $976,063 in post-closure costs. The 2016 Remedial Cost Estimate is approved.

If you have any questions regarding this letter, please contact me at (510) 540-3776 or at Tom.Lanphar@dtsc.ca.gov.

Sincerely,

Thomas P. Lanphar
Senior Environmental Scientist
Brownfields and Environmental Restoration Program

cc: Bob Schmidt
Coast Wood Preserving, Inc.
P.O. Box 1805
Turlock, California 95381
CFVWoodPreserve@aol.com

Richard Thomasser
Montgomery Watson Harza
2121 California Boulevard
Walnut Creek, California 94597
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Tu Nguyen
CA Site Cleanup Section II
United States Environmental Protection Agency Region 9
75 Hawthorne Street (SFD-7-2)
San Francisco, California 94105
Nguyen.Anhtu@epamail.epa

Kristine McIlvenna
MWH
Kristine.McIlvenna@us.mwhglobal.com

FINAL COST ESTIMATE AMOUNT

BRANCH CHIEF ACCEPTANCE MEMO

Site Name: **Coast Wood Preserving**

DTSC Site Code: **200021-00**

I have reviewed the Financial Assurance Cost Estimate Initial Findings Memorandum or validation submitted by the Cost Estimation Working Group. I accept $ 976,063 as the final cost estimate amount for purposes of financial assurance. The Financial Responsibility Unit should use this amount to assign or validate an existing financial mechanism.

Listed below are the factors I considered as justification for this amount.

5/27/16 Financial Assurance Cost Estimate Validation memorandum.

Branch Chief Name: Janet Naito

Signature: Janet Naito

Date: 5/27/2016

Division Chief Name: ______________________

Signature: ______________________

Date: ______________

Department of Toxic Substances Control

Matthew Rodriquez
Secretary for
Environmental Protection

Barbara A. Lee, Director
700 Heinz Avenue
Berkeley, California 94710-2721

Edmund G. Brown Jr.
Governor

FINANCIAL ASSURANCE COST ESTIMATE VALIDATION MEMORANDUM

TO: Tom Lanphar, Project Manager
Cleanup Program, Berkeley Office

VIA: Jonathan Largent, P.E.
Cleanup Program, Berkeley Office

FROM: Jayantha Randeni, P.E.
Cleanup Program – Berkeley Office

SUBJECT: REVIEW OF THE FINANCIAL ASSURANCE COST ESTIMATE FOR COAST WOOD PRESERVING SITE (SITE CODE 200021-00)

DATE: May 27, 2016

DOCUMENTS REVIEWED

- 2016 Review of Remedial Action Cost Estimate, April 29, 2016.
- Covenant and Agreement, Coast Wood Preserving Inc., September 25, 1989.
- Remedial Action Certification Form, Coast Wood Preserving Site, June 29, 2007.
- Coast Wood Preserving, Fourth Five-Year Review, September 2011
- Coast Wood Preserving, 2015 Annual Groundwater Monitoring Report, February 28, 2016

COST ESTIMATE VALIDATION

The Department of Toxic Substances Control (DTSC) Cost Estimating Work Group (CEWG) engineering staff reviewed the Responsible Party (RP) Financial Assurance Cost estimate, dated April 29, 2016, for the Coast Wood Preserving (CWP) Site (Site) located in Ukiah, California. The purpose of our review is to determine if the estimated

dollar amount of $976,063 is sufficient for compliance with the financial assurance requirements established for the Site. The cost estimate covers operation and maintenance (O&M) activities related to remedial actions completed in 2007 as well as additional remedial activities and O&M activities following plant closure.

CWP has operated a wood preserving facility since 1971. Previous operations at the facility resulted in arsenic and chromium impacts to the soil and shallow groundwater underlying the site. CWP installed a slurry wall to contain chromium-impacted groundwater on site in 1983 and has conducted a program of extraction and reuse of impacted groundwater collected up-gradient of the slurry wall. These remedial actions were described in the Remedial Action Plan (RAP) prepared for the Site (Geosystem Consultants, Inc., September 1989), and approved by DTSC.

An asphalt/concrete cap covers the entire site, eliminating direct contact exposure to arsenic- and chromium-contaminated soils and preventing leaching of contaminants into groundwater. The land use covenant that was recorded in 1989 requires the maintenance of an asphalt or concrete cap over the Site until such time as the soil remedy is implemented in accordance with the approved RAP and restricts the use of the property to non-residential purposes.

A RAP Amendment for remedy enhancements was approved in July 1999. These enhancements involved the use of an in-situ reduction and fixation approach for chromium. The California Regional Water Quality Control Board (CRWQCB) approved Waste Discharge Requirements (WDR) Order No 99-45 authorizing the proposed in-situ reduction program and establishing groundwater monitoring and sampling requirements. Reductant injection was conducted during eight injection programs between 1999 and 2010. Injection of reductant solution has decreased groundwater dissolved chromium concentrations and has prevented off-site plume migration.

In 2003, an Explanation of Significant Differences (ESD) was prepared to revise the cleanup goals for hexavalent chromium and arsenic in soil. The RAP anticipated that soil cleanup would not be undertaken until the cessation of wood-preservation activities at the Site. In 2003, CWP proposed that some accessible contaminated soil could be remediated during plant operation due to upgrades that were being made. Three separate soil removals were performed beginning 2003.

Currently, there is no O&M plan for the Site and the groundwater monitoring is conducted under the WDR order. According to the project manager, the plant closure is expected to happen in the near future, all contaminated soil is expected to be excavated after the plant closure and groundwater cleanup goals will be achieved within 5 years. Therefore, only land use restriction will continue for industrial use with no cap requirement.

In order to accurately evaluate the costs associated with operation and maintenance (O&M) of the Sites, the following assumptions were made:

1) Duration of O&M Activities. For cost estimating purposes, the duration of O&M activities is projected for 30 years.
2) Net Present Value Discount Rate. A discount rate of 1.5% was used in the net present value calculation, based on the November 2015 30-year Real Interest Rates on Treasury Notes and Bonds presented in Whitehouse Circular A-94 Appendix C.
3) Terradex Monitoring Costs. The net present value of 30 years of Terradex monitoring costs at a monthly rate of $29 is approximately $13,000.
4) Remediation costs after Plant Closure. Soil, concrete and asphalt volumes, number of pre-excavation of soil samples, number of confirmation soil samples, soil excavation, transportation, and disposal costs were obtained from the RP cost estimate.
5) Groundwater Sampling Costs. Semi-annual monitoring was projected for 2 years and annual monitoring for 3 years as directed by project manager. This monitoring schedule is the same as proposed in the RP estimate. Groundwater samples from 22 wells will be analyzed for arsenic, chromium, manganese, calcium, ammonia and sulfate, and 8 samples will be analyzed for hexavalent chromium.
6) Groundwater Injections. 2 calcium polysulfide reductant injections were used in the cost estimate as directed by project manager.
7) Site inspection costs. No cap maintenance costs were included.
8) Oversight costs. 2 years of water board WDR fees and 30 years of DTSC oversight costs were assumed.

Based on my review of the above listed documents, I have generated a cost estimate for the net present value amount of $1,030,226 in current U.S. dollars utilizing sound engineering principles and judgment and RSMeans. The details of my independent cost estimate are included in the attached tables. I have concluded the RP Cost Estimate amount of $976,063 in current U.S. dollars is within 10% of my cost estimate and is adequate for a third party to implement the remedy and perform the requisite corrective measures at the Site.

The CEWG review was based on the information available at the time the review was performed and does not constitute a guarantee of the accuracy of the assumptions used by the responsible party to develop their financial assurance cost estimate. The review of this financial assurance cost estimate is not intended to be all-inclusive as this review does not include a technical assessment and evaluation of the remedial design/controlling document or the accuracy and reliability of data used to support the assumptions.

If you have any questions or wish to discuss this memorandum further, please contact me at (510) 540-3806.

The Financial Assurance Cost Estimate and supporting documentation was reviewed under the responsible charge of the following qualified Civil Engineer registered in the State of California.

Seal

REGISTERED PROFESSIONAL ENGINEER
JAYANTHA S. RANDENI
No. C49609
Exp. 9/30/16
CIVIL
STATE OF CALIFORNIA

Name: Jayantha Randeni, P.E.

Signature: JRandeni Date: 5/27/2016

Quality Assurance Reviewer: Date: 5/27/2016

If you will be asking the Financial Responsibility Unit to review, modify, or initiate development of a financial assurance mechanism for this site now or in the future, the Branch Chief Acceptance Memo must be completed and submitted with the EnviroStor work request sent to the Financial Responsibility Unit.

Attachments:

1. DTSC Financial Assurance Cost Estimate
   Table 1: Operation and Maintenance Task Event Cost
   Table 2: Net Present Value Calculation
2. Responsible Party Financial Assurance Cost Estimate

Table 1
Operation and Maintenance Cost Estimate
Coast Wood Preserving
DTSC Financial Assurance Cost Estimate Review

Task Description	QTY	UOM	M	L	E	O&P	Total	Comments
1. Excavation								
Pre-excavation work plan								
Pre-excavation work plan	1	EA				$ 6,000.00	$ 6,000.00	DTSC estimate
DTSC Toxicologist	4	HR		$148.00	$ -	$ -	$ 592.00	DTSC estimate
DTSC public Participation	4	HR		$125.00	$ -	$ -	$ 500.00	DTSC estimate
DTSC Project Manager (HSS)	20	HR	$ -	$ 152.00	$ -	$ -	$ 3,040.00	DTSC estimate
DTSC Sup Scientist	4	HR	$ -	$ 215.00	$ -	$ -	$ 860.00	DTSC estimate
Pre-excavation Soil Sampling								
Project Assistant	72	HR		$88.00		$ -	$ 6,336.00	DTSC estimate
Staff Engineer	20	HR		$ 108		$ -	$ 2,160.00	DTSC estimate
DTSC Project Manager (HSS)	10	HR	$ -	$ 152.00		$ -	$ 1,520.00	DTSC estimate
Field Equipment	1	EA			$3,000.00	$ -	$ 3,000.00	DTSC estimate
Project Manager	8	HR		$108.00		$ -	$ 864.00	DTSC estimate
Lab: Hex Chromium	238	EA		$50.00		$ -	$ 11,900.00	DTSC estimate
Lab: arsenic	238	EA		$11.00		$ -	$ 2,618.00	DTSC estimate
Waste Disposal	1	EA	$500.00			$ -	$ 500.00	DTSC estimate
Pre-Excavation Sampling Report	1	EA				$ 6,000.00	$ 6,000.00	DTSC estimate
DTSC Project Manager (HSS)	20	HR	$ -	$ 152.00	$ -	$ -	$ 3,040.00	DTSC estimate
DTSC Sup Scientist	4	HR	$ -	$ 215.00	$ -	$ -	$ 860.00	DTSC estimate
						Pre-Excavation Sampling	$ 49,790.00	2017
Excavation Workplan								
Excavation work plan	1	EA				$ 10,000.00	$ 10,000.00	DTSC estimate
DTSC public Participation	4	HR		$125.00	$ -	$ -	$ 500.00	DTSC estimate
DTSC Project Manager (HSS)	20	HR	$ -	$ 152.00	$ -	$ -	$ 3,040.00	DTSC estimate
DTSC Sup Scientist	4	HR	$ -	$ 215.00	$ -	$ -	$ 860.00	DTSC estimate
						Excavation Workplan	$ 14,400.00	2017
Soil, concrete and asphalt Excavation								
Excavation, backfill	1	EA	$ -	$ -	$ -	$ 90,000.00	$ 90,000.00	RP cost Estimate
Transportation/Disposal at Class 1	1	EA	$ -	$ -	$ -	$ 348,290.00	$ 348,290.00	RP cost Estimate
Paving	1	EA	$ -	$ -	$ -	$ 85,000.00	$ 85,000.00	RP cost Estimate
DTSC Project Manager (HSS)	10	HR	$ -	$ 152.00	$ -	$ -	$ 1,520.00	DTSC estimate
						Excavation Cost	$ 524,810.00	2017
Confirmation Soil Sampling								
Project Assistant	40	HR	$ -	$88.00	$ -	$ -	$ 3,520.00	DTSC estimate
Staff Engineer	8	HR	$ -	$ 108	$ -	$ -	$ 864.00	DTSC estimate
DTSC Project Manager (HSS)	10	HR	$ -	$ 152.00	$ -	$ -	$ 1,520.00	DTSC estimate
Field Equipment	1	EA	$ -	$ -	$500.00	$ -	$ 500.00	DTSC estimate
Lab: Hex Chromium	198	EA	$ -	$50.00	$ -	$ -	$ 9,900.00	DTSC estimate
Lab: arsenic	198	EA	$ -	$11.00	$ -	$ -	$ 2,178.00	DTSC estimate
						Confirmation Sampling	$ 18,482.00	2017
Implementation Report								
Implementation Report	1	EA				$ 8,000.00	$ 8,000.00	DTSC estimate
DTSC Project Manager (HSS)	20	HR	$ -	$ 152.00	$ -	$ -	$ 3,040.00	DTSC estimate
DTSC Sup Scientist	4	HR	$ -	$ 215.00	$ -	$ -	$ 860.00	DTSC estimate
						Excavation Cost	$ 11,900.00	2017
						Task 1 Excavation Cost	$ 619,382.00	2017
2. Groundwater Monitoring, and Reporting								
Groundwater Sampling and Analysis								
Project Assistant	24	HR	$ -	$88.00	$ -	$ -	$ 2,112.00	DTSC estimate
Field Equipment	1	EA	$ -	$ -	$500.00	$ -	$ 500.00	DTSC estimate
Project Manager	2	HR	$ -	$108.00	$ -	$ -	$ 216.00	DTSC estimate
Lab: As, Cr, Ca, Ammonia, sulfate	25	EA	$ -	$244.00	$ -		$ 6,100.00	RP estimate
lab: hex Cr	9	EA	$ -	$50.00	$ -	$ -	$ 450.00	RP estimate
Waste Disposal	1	EA	$500.00	$ -	$ -		$ 500.00	DTSC estimate
						Sampling Subtotal	$ 9,878.00	Starting 2017
Reporting								
Principal	1	HR	$ -	$ 211.00	$ -	$ -	$ 211.00	DTSC estimate
Staff Engineer	20	HR	$ -	$ 108.00	$ -		$ 2,160.00	DTSC estimate
Project Assistant	20	HR	$ -	$ 88.00	$ -	$ -	$ 1,760.00	DTSC estimate

Table 1
Operation and Maintenance Cost Estimate
Coast Wood Preserving
DTSC Financial Assurance Cost Estimate Review

Task Description	QTY	UOM	M	L	E	O&P	Total	Comments
Drafting	10	HR	$ -	$ 98.00	$ -	$ -	$ 980.00	DTSC estimate
DTSC Geologist	10	HR	$ -	$ 195.00	$ -	$ -	$ 1,950.00	DTSC estimate
DTSC Project Manager (HSS)	20	HR	$ -	$ 152.00	$ -	$ -	$ 3,040.00	DTSC resource estimation sheet
DTSC Sup Scientist	2	HR	$ -	$ 215.00	$ -	$ -	$ 430.00	DTSC resource estimation sheet
						Reporting Subtotal	$ 10,531.00	
						Task 2 GW monitoring	$ 20,409.00	2 semi annual and 3 annual starting 2017
3. Groundwater Remediation								
Groundwater Injection Workplan								
Staff Engineer	40	HR	$ -	$ 108.00	$ -	$ -	$ 4,320.00	DTSC estimate
Project Assistant	30	HR	$ -	$88.00	$ -	$ -	$ 2,640.00	DTSC estimate
Field Equipment	1	EA	$ -	$ -	$500.00	$ -	$ 500.00	DTSC estimate
Project Manager	2	HR	$ -	$108.00	$ -	$ -	$ 216.00	DTSC estimate
DTSC public Participation	4	HR	$ -	$125.00	$ -	$ -	$ 500.00	DTSC estimate
DTSC Geologist	10	HR	$ -	$ 195.00	$ -	$ -	$ 1,950.00	DTSC estimate
DTSC Project Manager (HSS)	8	HR	$ -	$ 152.00	$ -	$ -	$ 1,216.00	DTSC estimate
DTSC Sup Scientist	2	HR	$ -	$ 215.00	$ -	$ -	$ 430.00	DTSC estimate
						Workplan	$ 11,772.00	Starting 2018
Calcium Plolysulfide Injections								
Calcium Plolysulfide	1	EA	$ -	$ -	$6,895.00	$ -	$ 6,895.00	RP Estimate
Injection labor	1	EA	$ -	$ -	$18,000.00	$ -	$ 18,000.00	RP Estimate
DTSC Project Manager (HSS)	10	HR	$ -	$ 152.00	$ -	$ -	$ 1,520.00	DTSC resource estimation sheet
						Injection Field work	$ 26,415.00	Starting 2018
Implementation Report								
Principal	4	HR	$ -	$ 211.00	$ -	$ -	$ 844.00	DTSC estimate
Staff Engineer	40	HR	$ -	$ 108.00	$ -	$ -	$ 4,320.00	DTSC estimate
Project Assistant	20	HR	$ -	$ 88.00	$ -	$ -	$ 1,760.00	DTSC estimate
Drafting	10	HR	$ -	$ 98.00	$ -	$ -	$ 980.00	DTSC estimate
DTSC Geologist	10	HR	$ -	$ 195.00	$ -	$ -	$ 1,950.00	DTSC estimate
DTSC Project Manager (HSS)	20	HR	$ -	$ 152.00	$ -	$ -	$ 3,040.00	DTSC resource estimation sheet
DTSC Sup Scientist	2	HR	$ -	$ 215.00	$ -	$ -	$ 430.00	DTSC resource estimation sheet
						Reporting Subtotal	$13,324.00	
						Task 3 GW remediation	$ 51,511.00	2 events 2017 and 2018
4. WDR Permit Fees								
WDR Permit Fee	1	EA	$ -	$ -	$ 9,515.00	$ -	$ 9,515.00	RP Estimate
						Task 4 WDR Fees	$ 9,515.00	2 events 2017 and 2018
5. DTSC Project Management								
DTSC Project Manager (HSS)	12	HR	$ -	$ 152.00	$ -	$ -	$ 1,824.00	DTSC resource estimation sheet
DTSC Sup Scientist	1	HR	$ -	$ 215.00	$ -	$ -	$ 215.00	DTSC resource estimation sheet
						Task 5 DTSC PM	$ 2,039.00	Annually
6. Five Year Review (5YR)								
Principal	4	HR	$ -	$ 211	$ -	$ -	$ 844.00	DTSC estimate
Staff Engineer	32	HR	$ -	$ 108	$ -	$ -	$ 3,456.00	DTSC estimate
Administrative Assistant	4	HR	$ -	$ 75	$ -	$ -	$ 300.00	DTSC estimate
Drafting	4	HR	$ -	$ 98	$ -	$ -	$ 392.00	DTSC estimate
DTSC Project Manager	20	HR	$ -	$ 152	$ -	$ -	$ 3,040.00	DTSC estimate
DTSC Engineer	4	HR	$ -	$ 193	$ -	$ -	$ 772.00	DTSC estimate, FA Cost Estimate Review
DTSC AGPA	4	HR	$ -	$ 126	$ -	$ -	$ 504.00	DTSC estimate, FA Mechanism Review
DTSC PPS	4	HR	$ -	$ 126	$ -	$ -	$ 504.00	DTSC estimate
DTSC Toxicologist	4	HR	$ -	$ 180	$ -	$ -	$ 720.00	DTSC estimate
DTSC Sup Scientist	4	HR	$ -	$ 215	$ -	$ -	$ 860.00	DTSC estimate
						Task 6 5-Year Review	$ 11,392.00	2021, every five years thereafter
7. Well Decommissioning								
Drill Rig Crew	1	EA		$ 1,815.64	$ 719.23	$ -	$ 2,534.87	RSMeans No. 332113108570, RACER
Move Drill Rig	26	EA	$ 101.58	$ 261.00	$ 103.39	$ -	$ 12,115.22	RSMeans No. 332113108560, RACER
Hollow Stem Auger, 11"	492	LF	$ -	$ 20.45	$ 22.41	$ -	$ 21,087.12	RSMeans No. 023223135112, RACER
Grout Continuous Borehole	240	CF	$ 7.20	$ -	$ -	$ -	$ 1,728.00	RSMeans No. 023223136142, RACER
Field Technician	72	HR	$ -	$ 46.32	$ -	$ -	$ 3,335.04	Racer Estimate
Waste Disposal	1	each	$ 4,000.00				$ 4,000.00	Racer Estimate
						Task 7 Well Decommission	$ 44,800.25	Well closure 2024

Table 1
Operation and Maintenance Cost Estimate
Coast Wood Preserving
DTSC Financial Assurance Cost Estimate Review

Task Description	QTY	UOM	M	L	E	O&P	Total	Comments
8. Terradex Monitoring								
Terradex Monitoring Fee	12	Month	$ -	$ -	$ 29.00	$ -	$ 348.00	DTSC estimate
DTSC Project Manager (HSS)	1	HR	$ -	$ 152.00	$ -	$ -	$ 152.00	DTSC estimate
				Task 8 Terradex Cost			$ 500.00	Annually

QTY: Quantity	UOM: Unit of Measurement	M: Material	L: Labor
E: Equipment	O&P: Overhead and Profit	HR: Hour	LF: Linear Foot
SY: Square Yard	EA: Each	CF: Cubic Foot	

RACER: Remedial Action Cost Engineering and Requirements software, Version 11.1

Table 2
Net Present Value Calculation
Coast Wood Preserving
DTSC Financial Assurance Cost Estimate Review

Year	Task 1: Post-Closure Excavation	Task 2: GW Monitoring & Reporting	Task 3: Injections	Task 4:WDR Permit fees	Task5: DTSC PM Costs	Task 6: Five Year Reviews	Task 7: Well Closure	Task 8: Terradex Monitoring	Annual Cost	Net Present Value[1]
2017	$ 619,382	$ 40,818	$ 51,511	$ 9,515	$ 2,039			$ 500	$ 723,265	$ 723,265
2018		$ 40,818	$ 51,511	$ 9,515	$ 2,039			$ 500	$ 103,883	$ 102,348
2019		$ 20,409			$ 2,039			$ 500	$ 22,448	$ 21,789
2020		$ 20,409			$ 2,039			$ 500	$ 22,448	$ 21,467
2021		$ 20,409			$ 2,039	$ 11,392		$ 500	$ 33,840	$ 31,884
2022					$ 2,039			$ 500	$ 2,039	$ 1,893
2023					$ 2,039			$ 500	$ 2,039	$ 1,865
2024					$ 2,039		$ 44,800	$ 500	$ 46,839	$ 42,203
2025					$ 2,039			$ 500	$ 2,039	$ 1,810
2026					$ 2,039	$ 11,392		$ 500	$ 13,431	$ 11,747
2027					$ 2,039			$ 500	$ 2,039	$ 1,757
2028					$ 2,039			$ 500	$ 2,039	$ 1,731
2029					$ 2,039			$ 500	$ 2,039	$ 1,705
2030					$ 2,039			$ 500	$ 2,039	$ 1,680
2031					$ 2,039	$ 11,392		$ 500	$ 13,431	$ 10,904
2032					$ 2,039			$ 500	$ 2,039	$ 1,631
2033					$ 2,039			$ 500	$ 2,039	$ 1,607
2034					$ 2,039			$ 500	$ 2,039	$ 1,583
2035					$ 2,039			$ 500	$ 2,039	$ 1,560
2036					$ 2,039	$ 11,392		$ 500	$ 13,431	$ 10,122
2037					$ 2,039			$ 500	$ 2,039	$ 1,514
2038					$ 2,039			$ 500	$ 2,039	$ 1,492
2039					$ 2,039			$ 500	$ 2,039	$ 1,469
2040					$ 2,039			$ 500	$ 2,039	$ 1,448
2041					$ 2,039	$ 11,392		$ 500	$ 13,431	$ 9,396
2042					$ 2,039			$ 500	$ 2,039	$ 1,405
2043					$ 2,039			$ 500	$ 2,039	$ 1,385
2044					$ 2,039			$ 500	$ 2,039	$ 1,364
2045					$ 2,039			$ 500	$ 2,039	$ 1,344
2046				$ 9,515	$ 2,039	$ 11,392		$ 500	$ 22,946	$ 14,900
Total	$ 619,382	$ 142,863	$ 103,022	$ 28,545	$ 61,170	$ 68,352	$ 44,800	$ 15,000	$ 1,068,134	
NPV	$ 619,382	$ 139,590	$ 102,261	$ 25,068	$ 49,703	$ 53,897	$ 40,366	$ 12,188	NPV	**$ 1,030,266**

1. Net Present Value calculation utilized a discount rate of 1.4% from Whitehouse Circular A-94 Appendix C.

MWH

April 29, 2016

Mr. Thomas Lanphar
California Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710-2721

Re: 2016 Review of Remedial Action Cost Estimate
Coast Wood Preserving
Ukiah, California

Dear Mr. Lanphar:

MWH prepared the July 20, 2005 document "*Final Remedial Action Cost Estimate, Coast Wood Preserving Site, Ukiah, California*", which was submitted to the Department of Toxic Substances Control (DTSC) as required by Consent Decree *CV-F-96-6055 AWILJO* and approved as the total cost estimate for cleanup of the CWP site for financial assurance purposes. The original 2005 document included interim and post closure costs for both soil and groundwater remedial action and monitoring.

The Consent Decree requires periodic review of the cost estimate. MWH completed the first review of the estimated costs in 2009 considering the interim remedial action activities that had been completed since the 2005 estimate was prepared. The second review of the costs for cleanup of the CWP site (Site) was submitted in December 2012 to reflect additional activities that had been completed since 2009. In addition, as applicable, CWP and MWH reviewed unit costs (e.g. laboratory, construction, transportation and disposal costs). The second revision of the cost estimate was updated in September 2013 based on DTSC comments in a letter dated February 15, 2013 and further revised based on additional DTSC comments and finalized on November 11, 2013, including consideration of the State of California Department of Public Health's plan to adopt a new Maximum Contaminant Level (MCL) for hexavalent chromium of 10 ug/L, with respect to its impact on the costs of remedial action and the overall protectiveness of the approved remedy for the Site.

This document represents the third triennial review of the remedial action cost estimate based on 2016 Site conditions and unit costs. Since submittal of the last update in November 2013, the DTSC conducted a review of the financial assurance cost estimate and submitted comments in a letter dated October 31, 2014. This third review of the cost estimate addresses the comments in that letter.

Soil Remedial Action Costs

The 2005 cost estimate included $248,200 for interim soil remedial action costs and $519,050 for soil remedial action once the plant closes. CWP completed all of the interim soil remedial actions identified

between August 30, 2005 and December 16, 2005 and prepared the report *Final Summary of Characterization and Removal of Soil beneath the Former Northern Storm Water Tank Farm and 330,000 Gallon Water Tank Report* dated January 13, 2006, revised September 22, 2006. This report was approved by DTSC on November 8, 2006. Based on the soil removal actions completed, the only remaining soil remedial actions are those identified to be performed upon plant closure. In 2015, CWP completed demolition of the lumber incisor pedestal, which included removal of previously unidentified soil impacts. Other than the completed soil removal associated with this demolition activity, no new soil source areas have been identified. And no further interim soil removal actions are planned. The unit costs for post closure soil removal and disposal are consistent with the 2015 work; therefore, the cost assumptions presented in the remedial action cost estimate remain valid. The 2016 post closure cost estimate for soil remedial action is $621,817.

Groundwater Remedial Action Costs

The 2005 cost estimate included 10 years of quarterly groundwater monitoring and sampling and 5 *in-situ* reductant injection events for interim groundwater remedial action during plant operations. The 10 years of monitoring and sampling was estimated to cost $238,040 and the 5 reductant injection events estimated at $81,875. The 2005 total interim groundwater remedial action cost estimate was therefore $319,915. Additionally, it was estimated that there would be agency oversight fees totaling $84,836.

CWP has conducted ongoing groundwater monitoring and sampling and has completed 4 of the estimated 5 reductant injection events since 2006. For the purpose of this cost estimate, that interim remedial measures and associated groundwater monitoring and sampling are considered complete. The California Department of Public Health Maximum Contaminant Level (MCL) for hexavalent chromium of 10 ug/L has been considered with respect to the residual groundwater concentrations. Except for isolated occurrences, most wells already meet the new MCL of 10 ug/L for hexavalent chromium and existing MCL of 50 ug/L for dissolved chromium. Therefore, one additional *in-situ* treatment is included in the post closure cost estimate as a contingency to reduce the timeframe for all Site wells to reach the new lower MCL. The timing of this additional injection event (if required) would be following completion of soil remedial actions. The costs for an Injection Implementation Work Plan, and a Groundwater Remedial Action Completion Report have been included in the cost estimate.

Given the land use restrictions in place, prohibiting the construction of production wells on the Site, the adoption of the 10 ug/L MCL for hexavalent chromium would not affect the overall protectiveness of the existing approved groundwater remedy. The inclusion of costs for a single contingent injection event is considered appropriate given that most wells already exhibit concentrations below the proposed new MCL.

The post closure groundwater remedial action and monitoring costs have been updated to reflect the current number of wells included in the monitoring program. The post closure operations and maintenance costs have been updated based on DTSC review of the 2013 remedial cost estimate to include a Site Closure Request, 30 years of post closure inspections and reporting and abandonment of all remaining groundwater monitoring wells. The unit costs and related post closure agency oversight costs of $58,870 remain valid. The following table summarizes the remedial action costs estimate in 2005 compared to April 2016:

Summary Updated Cost Estimate

	2005 Interim Costs	2016 Interim Costs	2005 Post Closure Costs	2016 Post Closure Costs
Soil Remedial Actions	$ 248,200	$ 0	$ 519,050	$ 621,817
Groundwater Remedial Actions	$ 319,915	$ 0	$153,204	$ 134,643
Post Closure O&M	$ 0	$ 0	$ 0	$ 57,000
Regulatory Fees and Oversight	$ 84,836	$ 0	$ 58,289	$ 58,870
Five Year Review	$ 0	$ 0	$ 0	$ 15,000
10% Contingency	$ 65,295	$ 0	$ 69,731	$ 88,733
Total Estimate	**$ 718,246**	**$ 0**	**$ 767,041**	**$ 976,063**

The original 2005 cost estimate, annotated to reflect work completed and updated with current unit costs as of April 2016, is attached. CWP reports that there are adequate funds in the established trust fund to cover post closure costs. If there are any questions, please feel free to call me at 707-227-0407.

Sincerely,
MWH

Richard M. Thomasser, P.G.
Principal Hydrogeologist

Attachment: Revised Cost Estimate Details updated as of April 2016

cc (via email):
Keith Baldanza, NCRWQCB
Anhtu, Nguyen, U.S. EPA
Mr. Bob Schmidt, Coast Wood Preserving
Mr. Gene Pietila, Coast Wood Preserving
Mr. Jim Rouse, Acuity Environmental Solutions
Ms Krissi McIlvenna, MWH

Appendix A
Final Cost Estimate Summary
Coast Wood Preserving Site

July 20, 2005
First Revision December 2009
Second Revision December 2012 (updated as of September 2013)
Third Revision April 2016

The following assumptions form the basis for this third revised remedial action cost estimate for soil and groundwater at the Coast Wood Preserving (CWP) site as of April 2016. For comparison purposes, this third revised cost estimate summary follows the format for the original cost estimate that was included in Attachment A of the MWH report *Final Remedial Cost Estimate,* dated July 20, 2005. Unit costs have been updated to reflect current costs, and the number of wells sampled has been updated to reflect the current approved monitoring program. The changes that have been made to update the original 2005 estimate are shown with strikeout (~~strikeout~~) text and new costs. Interim remedial actions identified in the original cost estimate have been performed and all future remedial activities included in this cost estimate are assumed to be performed following closure of the CWP Plant.

General Assumptions

1. Soil requiring removal was identified in the nine areas listed in the following section with their dimensions and assumed depth of contamination. Three of these areas and part of one have been completed as interim actions since the 2005 cost estimate was prepared. All remaining soil cleanup actions will occur following closure of the CWP Plant.
2. Groundwater remediation includes costs for groundwater monitoring and sampling for 5 years following plant closure. The newly adopted Maximum Contaminant Level (MCL) for hexavalent chromium of 10 ug/L has been considered with respect to the residual groundwater concentrations. Except for isolated occurrences, most wells already meet the new MCL of 10 ug/L for hexavalent chromium and existing 50 ug/L total chromium; therefore only limited additional *in-situ* treatment may be warranted. As a contingent measure, one additional phase of reductant injection to be performed following post closure soil remedial action is included in the cost estimate to reduce the timeframe for all Site wells to reach the lower MCL of 10 ug/L for hexavalent chromium. Furthermore, given the land use restrictions in place, prohibiting the construction of production wells on the Site, the adoption of a new MCL for hexavalent chromium would not affect the overall protectiveness of the existing approved groundwater remedy.
3. Soil and groundwater remediation costs will be revisited periodically to adjust the estimated costs based on current site conditions. The 5-year review will also be used to reassess remedial progress at the site and adjust the estimated costs if necessary.
4. All costs are based on work performed by a third party.
5. Costs for soil excavation, transportation, disposal, and backfill are based on recent soil remediation completed at the site and other similar sites.
6. All post-closure soil remediation areas will be paved upon completion.
7. California Regional Water Quality Control Board (RWQCB) waste discharge requirement (WDR) fees will be required for two years following plant closure.

8. Included are costs for DTSC oversight for 5 years after plant closure following the cost schedule outlined in their letter dated December 10, 2004.

Exclusions

1. Costs do not include removal of sludge or decontamination of existing process tanks since this was completed during the 2003-2004 facility upgrade for use of a new preservative compound. Costs only include removal of tanks overlying proposed soil remediation areas. The removed tanks may be sold for scrap metal or reuse.

I. SOIL REMEDIATION

Nine areas requiring soil remedial action were identified. These areas have been further separated into groups to be excavated either as interim actions during plant operations, or after the plant closes, based on access constraints. All areas identified for interim soil removal have been completed.

Interim Soil Remediation Areas (WORK COMPLETED IN 2005)

Mix tank farm
Area (40 ft. x 50 ft. = 2000 square feet)
Concrete surface (2000 sq. ft. x 8in. = 49 cubic yards)
Soil Volume (2000 sq. ft x 5ft = approx. 370 cubic yards minus surface cover = 321 cubic yards)

Utility trench east of mix tank farm
Area (90 ft. x 10 ft = 900 square feet)
Concrete surface (900 sq. ft. x 6in = 17 cubic yards)
Volume for excavation to 8 feet (200 square ft x 8 ft = approx. 59 cubic yards)
Volume for excavation to 4 feet (100 square ft x 4 ft = approx. 15 cubic yards)
Volume for excavation to 1 foot (600 square ft x 1 ft = approx. 22 cubic yards)
Total Soil Volume (96 cubic yards minus surface cover = 79 cubic yards)

Interim Phase 3 excavation soil to be removed beneath the west side of the 330,000-gallon tank
Area (approximately 240 square feet)
Soil Volume (18 cubic yards)

South of drip pad and beneath the northern storm water tank farm
Area (120 ft. x 30 ft = 3600 square feet)
Concrete surface (1540 sq.ft. x 8 in. = 38 cubic yards)
Asphalt surface (450 sq. ft. x 3 in. = 4 cubic yards)
Open surface (1610 sq. ft.)
Volume for excavation to 5 feet (1500 square ft x 5 ft = approx. 278 cubic yards)
Volume for excavation to 2 feet (2100 square ft x 2 ft = approx. 156 cubic yards)
Total Soil Volume (434 cubic yards minus surface cover = 392 cubic yards)

Total Volume of Materials removed during Plant Operations:

Total concrete surface material = 104 cubic yards (156 tons)
Total asphalt surface material = 4 cubic yards (6 tons)
Total soil = 810 cubic yards (1215 tons)

Remediation Following Plant Closure Area

Drip pad beneath the two canopies east of the retort tanks
Area (120 ft x 100ft = 12,000 square feet)
Concrete Surface (5,500 sq.ft. x 8 in. = approx. 136 cubic yards)
Asphalt Surface (6,500 sq. ft. x 4 in. = approx. 80 cubic yards)
Soil Volume (12,000 sq. ft. x 2 ft = approx. 889 cubic yards minus surface cover = 673 cubic yards)

Drip pad beneath canopy north of the retort tanks
Area (100 ft x 25 ft = 1,250 square feet)
Asphalt Surface (1,250 sq.ft. x 8 in. = approx. 31 cubic yards
Soil Volume (1,250 sq. ft. x 2 ft = approx. 93 cubic yards minus surface cover = 62 cubic yards)

Retort sumps and drip pad beneath newly installed canopy
Area (60 ft x 50 ft = 3,000 square feet)
Concrete surface beneath retort tanks and sumps (450 sq.ft. x 8in. = approx. 11 cy)
Asphalt surface (2550 sq. ft. x 4in. = approx. 31 cubic yards)
Volume for excavation to 4 feet (1000 sq. ft x 4 ft = approx. 148 cubic yards)
Volume for excavation to 2 feet (2,000 sq. ft x 2 ft = approx. 150 cubic yards)
Total Soil Volume (298 cubic yards minus surface cover = 256 cubic yards)

Retort tanks, electrical building, and hazardous waste storage area

Area (50 ft x 45 ft = 2,250 square feet)
Concrete surface beneath retort tanks (1,250 sq.ft. x 8 in. = approx. 31 cy)
Concrete surface beneath electrical building and hazardous waste storage area (1,000 sq.ft. x 4in. = approx. 12 cy)
Volume for excavation to 3 feet (2,250 sq. ft x 3 ft = approx. 250 cubic yards)
Total Soil Volume (250 cubic yards minus surface cover = 207 cubic yards)

Work tank farm
Area (30 ft. x 40 ft. = 1,200 square feet)
Concrete surface (1,200 sq.ft x 8 in. = 30 cubic yards)
Soil Volume (1,200 square feet x 3 ft = approximately 133 cubic yards minus surface cover = 103 cubic yards)

Soil remaining in place following Phase 2 and 3 excavation and west of shop
Area (approximately 2940 square feet)
Concrete surface (1240 sq. ft. x 6 in. = 23 cubic yards)

Asphalt surface (1940 sq. ft. x 3 in. = 18 cubic yards)
Volume for excavation to 2 feet (2140 sq.ft. x 2 ft. = approx. 159 cubic yards)
Volume for excavation to 1 foot (800 sq. ft. x 1 ft. = approx. 30 cubic yards)
Total Soil Volume (206 cubic yards minus surface cover = 147 cubic yards)

Total Volume of Materials to be removed following Plant Closure:

Total concrete surface material = 243 cubic yards (365 tons)
Total asphalt surface material= 160 cubic yards (240 tons)
Total soil = 1448 cubic yards (2176 tons)

Costs associated with the removal and disposal of soil in each of the above mentioned areas are as follows:

	Interim Costs	Post Closure Costs
A. Soil Excavation Work Plans Includes scope of work for pre-excavation soil characterization, excavation oversight, air monitoring, and soil confirmation sampling. Also includes revisions to the existing Health and Safety Plan if required. Post Closure costs include Post Closure Work Plan and Remedial Action Work Notice preparation.		
Interim Work Plan Preparation **(COMPLETED 2005)**	~~$2,000~~ $0	
Post Closure Work Plan Preparation		*$9,000*
Soil Remedial Action Work Notice		*$1,500*
Total Soil Excavation Work Plans	**$0**	**$10,500**
B. Decommissioning of Tanks Costs for removal of tanks overlying areas to be excavated are included in the remedial construction labor cost below (see Section E)	**$0**	**$0**
C. Treat and Dispose of Tank Sludge As outlined in exclusion # 1, treatment and disposal of tank sludge has already been completed.	**$0**	**$0**

	Interim Costs	Post Closure Costs

D. Pre-Excavation Soil Characterization Sampling

The existing sampling grid system will be extended to all areas to be characterized prior to excavation. Soil sampling will be conducted on a 10-foot grid spacing to a depth of 4 feet bgs with the collection of 3 soil samples at each location.

Interim areas to be pre-characterized measures include the northern storm water tank pad south of the drip pad (60 feet x 30 feet) for a total of 18 sample locations or 54 characterization samples.

The areas to be pre-characterized following plant closure include beneath the work tank farm and retort sumps (approximately 80 feet x 40 feet) and the north side of the northern canopy (100 feet x 40 feet) for a total of 72 sample locations or 216 characterization samples.

	Interim Costs	Post Closure Costs
Interim Analytical Costs **(COMPLETED 2005)** (54 soil samples for arsenic and hexavalent chromium analysis at approximately \$60 per sample)	~~\$3,240~~ \$0	
Post Closure Analytical Costs (216 soil samples for arsenic and hexavalent chromium analysis at approximately ~~\$60~~ \$108 per sample)		~~\$12,960~~ \$23,328
Interim Sample Collection and Field Oversight **(COMPLETED 2005)**	~~\$2,000~~ \$0	
Post Closure Pre-Excavation Sample Collection Assumes 9 days of labor and equipment to complete pre-excavation sampling.		\$10,000
Interim Reporting **(COMPLETED 2005)**	~~\$2,000~~ \$0	
Post Closure Reporting		\$4,000
Total Interim Pre-Excavation Characterization (COMPLETED 2005)	**~~\$7,240~~** **\$0**	
Total Pre-Excavation Characterization Following Plant Closure		**~~\$26,960~~** **\$47,828**

	Interim Costs	Post Closure Costs
E. Remedial Construction		
***Interim Construction Costs* (COMPLETED 2005)** Excavation costs of $ 40 per cubic yard for 918 yards of surface cover and soil. (Includes subcontracted labor and equipment costs to remove all tanks and above ground structures over proposed excavation areas, remove approximately 108 cubic yards of surface cover, excavate approximately 810 cubic yards of soil and place fill material in all excavations requiring backfill).	~~*$36,720*~~ *$0*	
Disposal of 1,320 tons at $ 125 per ton (Includes transportation and disposal of 1,320 tons of soil and surface cover at a Class 1 landfill). It is assumed that 38 cubic yards (57 tons) of concrete from the northern storm water tanks farm can be transported to a concrete recycling facility following analytical testing.	~~*$165,000*~~ *$0*	
Paving costs of $ 27 per square yard to pave all excavated areas (6,740 square feet or 749 square yards) following backfill.	~~*$20,220*~~ *$0*	
Post Closure Construction Costs Excavation costs of ~~$40~~ $48.50 per cubic yard for 1851 yards of surface cover and soil. (Includes subcontracted labor and equipment costs to remove all tanks and above ground structures over proposed excavation areas, remove approximately 403 cubic yards of surface cover, excavate approximately 1,448 cubic yards of soil and place fill material in all excavations requiring backfill).		~~*$74,040*~~ *$89,774*
Disposal of 2,402 tons at $ ~~125~~ $145 per ton (Includes transportation and disposal of 2,402 tons of soil and surface cover at a Class 1 landfill). It is assumed that 232 cubic yards (348 tons) of concrete from the drip pad area, western retort tank area, work tank farm, east of the shop, and east of the Phase 2 excavation can be transported to a concrete recycling facility following scarification of the concrete surface and analytical testing. Also assumed is that 18 cubic yards of soil (27 tons) of asphalt from the Phase 2 and 3 excavation areas can be transported for recycling.)		~~*$300,250*~~ *$348,290*
Paving costs of ~~$ 27~~ $34 per square yard to pave all excavated areas (22,640 square feet or 2,516 square yards) following backfill.		~~$67,920~~ $85,544
Backfill material. Offsite backfill material will not be required Per Section 4.0 of the Revised Remedial Action Cost Estimate.		*$0*
Total Remedial Construction During Plant Operation (COMPLETED 2005)	**~~$221,940~~ $0**	
Total Remedial Construction Following Plant Closure		**~~$442,210~~ $523,608**

	Interim Costs	Post Closure Costs
F. Confirmation Sampling and Reporting		
Interim Analytical Costs (COMPLETED 2005) 67 soil samples for arsenic and hexavalent chromium analysis at approximately $60 per sample. Assumes an excavation area of 6,740 square feet with one confirmation sample for every 10 x 10 grid.	~~$4,020~~ $0	
Post Closure Analytical Costs 198 soil samples for arsenic and hexavalent chromium analysis at approximately ~~$60~~ $108 per sample. Assumes an excavation area of 19,790 square feet with one confirmation sample for every 10 x 10 grid.		~~$11,880~~ $21,381
Interim Excavation Oversight (COMPLETED 2005) Assumes 2 weeks of construction activity and includes confirmation sampling and air sampling.	~~$10,000~~ $0	
Post Closure Excavation Oversight Assumes 4 weeks of construction activity and includes confirmation sampling and air sampling.		$20,000
Interim Reporting (COMPLETED 2005)	~~$3,000~~ $0	
Post Closure Reporting		$9,000
Total Confirmation Sampling and Reporting During Plant Operation (COMPLETED 2005)	**~~$17,020~~ $0**	
Total Confirmation Sampling and Reporting Following Plant Closure		**~~$40,880~~ $50,381**

TOTAL SOIL REMEDIATION DURING PLANT OPERATION (COMPLETED 2005)	**~~$248,200~~ $0**	
TOTAL SOIL REMEDIATION AFTER PLANT CLOSURE		**~~$519,050~~ $621,817**

II. GROUNDWATER REMEDIATION

~~Assumes quarterly semi-annual groundwater monitoring and sampling and reductant injection and infiltration for ten years during plant operation.~~ Assumes 2 additional years of ~~quarterly~~ semi-annual monitoring and sampling and reductant injection and 3 years of ~~semi-~~annual monitoring and sampling following plant closure.

	Interim Costs	Post Closure Costs

A. Groundwater Monitoring and Sampling

Interim ~~Quarterly~~ Semi-Annual Monitoring and Sampling During Plant Operation (COMPLETED)

Assumes monitoring and sampling of ~~22~~ 25 wells ~~four~~ two times a year. In addition, 9 wells are analyzed for hexavalent chromium annually.

	Interim Costs	Post Closure Costs
Groundwater Analytical Costs per year (100 samples to be analyzed for arsenic, chromium, manganese, calcium ~~iron~~, ~~boron,~~ ammonia, and sulfate at $244 per sample. 9 samples to be analyzed for hexavalent chromium at $80 per sample).	~~*$12,804*~~ ~~*$25,120*~~ *$0*	
Labor per year No cost, assumes CWP Personnel will complete monitoring and sampling activities.		
Data Review and Reporting per year Assumes ~~3 quarterly~~ 1 semi-annual and one annual report.	~~*$11,000*~~ ~~*$9,000*~~ *$0*	
Total M&S 10 years (~~$23,804~~ $34,120 times 10 years) (DELETED ASSUMING PLANT CLOSURE)	**~~$238,040~~** **~~$341,200~~** **$0**	

~~Quarterly~~ Semi-Annual Monitoring and Sampling for 2 Years Following Plant Closure

Assumes monitoring and sampling of ~~22~~ 25 wells ~~four~~ two times a year. In addition, ~~9~~ 8 wells are analyzed for hexavalent chromium annually.

	Interim Costs	Post Closure Costs
Groundwater Analytical Costs per year (~~97~~ ~~100~~ 88 samples to be analyzed for arsenic, chromium, manganese, calcium, ~~iron, boron,~~ ammonia, and sulfate at ~~$132~~ $244 per sample. ~~9~~ 8 samples to be analyzed for hexavalent chromium at $80 per sample).		~~*$12,804*~~ ~~*$25,120*~~ *22,112*
Labor per year Includes contractor costs to perform ~~quarterly~~ semi-annual monitoring and sampling each year. Assumes ~~3~~2 days of field work ~~for 2 persons for each~~ at $500 per day per event.		~~*$4,000*~~ *$2,000*

	Interim Costs	Post Closure Costs
Data Review and Reporting per year Assumes ~~3 quarterly~~ 1 semi-annual and one annual report.		~~*$11,000*~~ *$9,000*
M&S for 2 years following plant closure (~~$27,804~~ ~~$36,120~~ $33,112 times 2 years)		~~$55,608~~ ~~$72,240~~ $66,224

~~Semi-~~Annual Monitoring and Sampling for 3 Additional Years Following Plant Closure
Assumes monitoring and sampling of ~~22~~ ~~25~~ 22 wells ~~2 times a year and 9 wells~~ annually.

	Interim Costs	Post Closure Costs
Groundwater Analytical Costs per year (~~53~~ ~~25~~ 22 samples to be analyzed for arsenic, chromium, manganese, calcium ~~iron, boron,~~ ammonia, and sulfate at ~~$132~~ $244 per sample and ~~9~~ 8 samples for hexavalent chromium at $80 per sample)		~~*$6,996*~~ ~~*$6,820*~~ *$6,008*
Labor per year Includes contractor costs to perform ~~quarterly~~ annual monitoring and sampling each year. Assumes ~~3~~ 2 days of field work ~~for 2 persons for each~~ at $500 per day per event.		~~*$2,000*~~ *$1,000*
Data Review and Reporting per year Assumes ~~1 semi-annual reports and~~ one annual report.		~~*$5,000*~~ *$4500*
Annual M&S for 3 additional years following plant closure) (~~$13,996~~ ~~$12,320~~ 11,508 times 3 years)		~~$41,988~~ ~~$36,960~~ $34,524
Total M&S for 5 years following plant closure		~~**$97,596**~~ ~~**$109,200**~~ **$100,748**

B. Reductant Injection and Trench Infiltration
Interim Reductant Injection and Trench Infiltration (COMPLETED)
Since 2005 four reductant injection events we completed during plant operation.

	Interim Costs	Post Closure Costs
Reductant Injection Labor Includes drilling subcontractor costs to inject reductant at an estimated 15 locations every two years. Assumes a 2-man crew for 2 days plus equipment.	~~*$12,000*~~ *$0*	
Calcium Polysulfide reductant Assumes to use of 1,500 gallons of reductant for direct push injection (100 gallons of reductant per location) and an additional 2,000 gallons per year for injection and	~~*$4,375*~~ ~~*$6,895*~~	

	Interim Costs	Post Closure Costs
infiltration of reductant into designated wells and trenches at $1.25$1.97 per gallon.	*$0*	
Field oversight of injection and infiltration Assumes CWP personnel will oversee the drilling contractor during the injection event and will conduct reductant injection and infiltration in wells and trenches.		
Total Reductant and Trench Infiltration During plant operation (~~$16,375~~ $ 18,895 times ~~5~~ 2 events) (COMPLETED)	**~~$81,875~~ ~~$30,895~~ $0**	
Reductant Injection Following Plant Closure Assumes one reductant injection event following plant closure. **Groundwater Injection Work Plan**		*$3,500*
Reductant Injection Labor Includes drilling subcontractor costs to inject reductant at an estimated 15 locations. Assumes a 2-man crew for 2 days plus equipment.		*$12,000*
Calcium Polysulfide reductant Assumes to use of 1,500 gallons of reductant for direct push injection (100 gallons of reductant per location) and an additional 2,000 gallons for injection and infiltration of reductant into designated wells and trenches at ~~$1.25~~ $1.97 per gallon.		*~~$4,375~~ $6,895*
Field oversight of injection and infiltration Assumes 2 days to oversee the drilling contractor during the injection event and 4 days to conduct reductant injection and infiltration in wells and trenches.		*$6,000*
Total Reductant and Trench Infiltration One event following plant operation (~~$22,375~~ $24,895)		**~~$22,375~~ $24,895**
Remedial Action Completion Report for Groundwater		**$9.000**
TOTAL GROUNDWATER REMEDIATION DURING PLANT OPERATION (COMPLETED)	**~~$319,915~~ ~~$372,095~~ $0**	
TOTAL GROUNDWATER REMEDIATION FOLLOWING PLANT CLOSURE		**~~$119,971~~ ~~$146,595~~ $134,643**

add 8 inject

III. POST CLOSURE OPERATIONS AND MAINTENANCE

A Site Closure Request and Post Closure O&M Plan will be prepared to outline Site maintenance activities after plant closure. The post closure O&M activities are those included in this cost estimate in addition to annual inspections to be performed by CWP personnel documenting compliance with land use covenants.

A.	**Prepare Site Closure Request and O&M Plan**	~~$2,500~~ $5,000
B.	**30 Years of Post Closure Site Inspections/Reporting**	$30,000
C.	**Abandonment of Groundwater Monitoring Wells**	$22,000

TOTAL POST CLOSURE O&M **$ 57,000**

IV. REGULATORY FEES AND OVERSIGHT COSTS

Assumes RWQCB WDR fees for 2 years following plant closure. Assumes 5 years of DTSC oversight following plant closure.

A. RWQCB WDR fees ($ 9,515 per year times 2 years) $19,030

B. DTSC Oversight Costs

10 years of DTSC oversight during plant operation (**COMPLETED**) ~~$84,836~~

5 years of DTSC oversight following plant closure $39,840

25 years

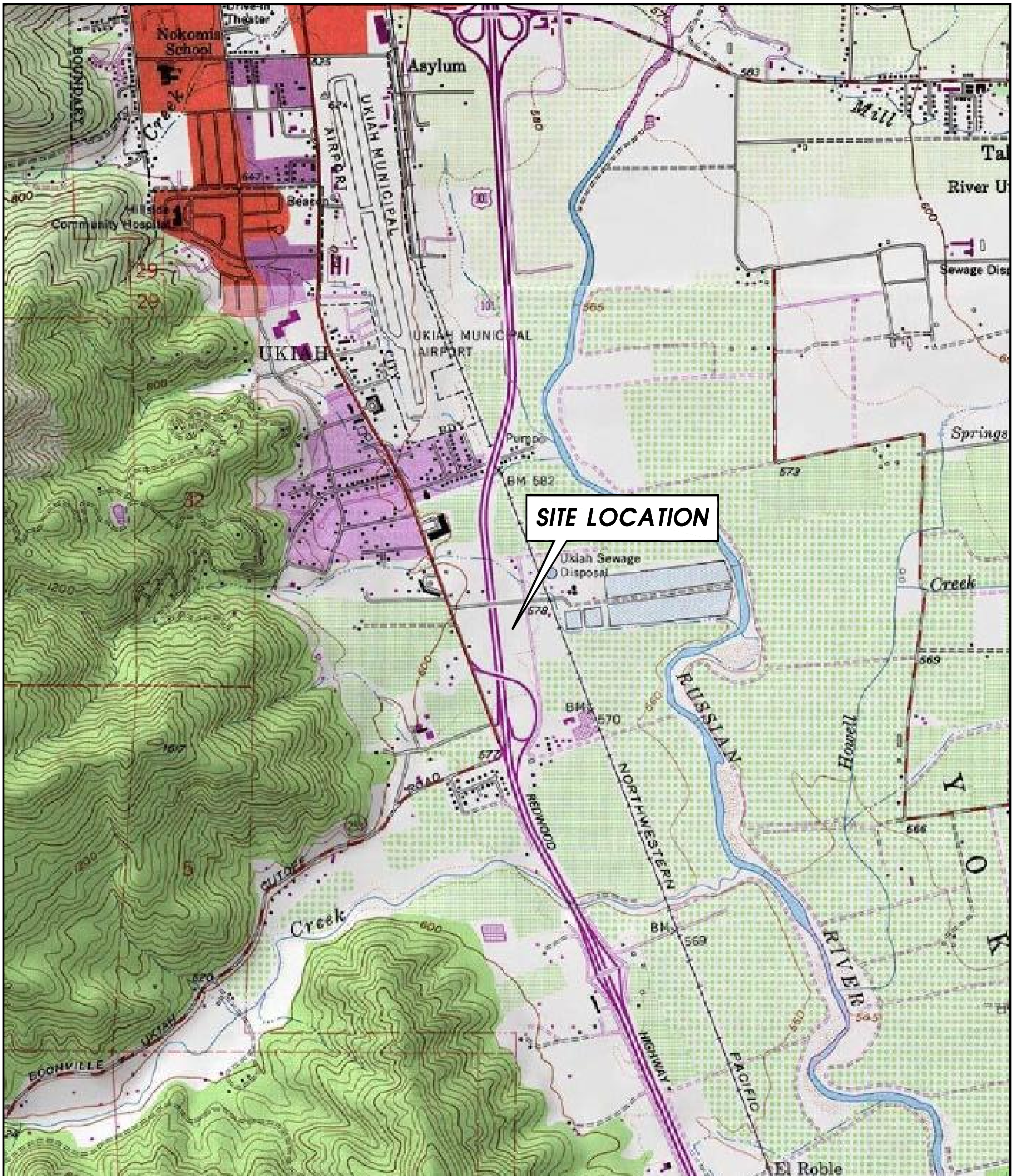
TOTAL REGULATORY FEES AND OVERSIGHT COSTS DURING PLANT OPERATION	~~**$84,836**~~	
TOTAL REGULATORY FEES AND OVERSIGHT COSTS FOLLOWING PLANT CLOSURE		**$58,870**

V. FIVE YEAR REVIEW **$15,000**

TOTAL COSTS FOR REMEDIATION DURING PLANT OPERATION	~~$652,951~~ ~~$456,931~~	
10% CONTINGENCY COST	~~$65,295~~ ~~$45,693~~	
GRAND TOTAL COSTS FOR REMEDIATION DURING PLANT OPERATION WITH 10% CONTINGENCY COST	~~$718,246~~ ~~$502,624~~ ~~$0~~	
TOTAL COSTS FOR REMEDIATION FOLLOWING PLANT CLOSURE		~~$697,310~~ ~~$812,701~~ ~~$844,782~~ $887,330
10% CONTINGENCY COST		~~$69,731~~ ~~$81,270$~~ ~~$84,480~~ $88,733
GRAND TOTAL COSTS FOR REMEDIATION FOLLOWING PLANT CLOSURE WITH 10% CONTINGENCY COST		~~$767,041~~ ~~$893,971~~ ~~$929,262~~ $976,063

APPENDIX G

Site Map



SOURCE: USGS QUAD SHEET
UKIAH, CALIFORNIA
WILDFLOWER TOPO PROGRAM

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SCALE

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MWH

COAST WOOD PRESERVING, INC.
UKIAH, CALIFORNIA

SITE LOCATION MAP

FIGURE 1

FILE: INDSVR\INDUSTRIAL\CAD MLUEBKE\COASTWOOD\SLMAP

JOB No.

APPENDIX H

SOW

STATEMENT OF WORK FOR COAST WOOD PRESERVING, INC.

1. Project Schedule.

Within thirty (30) days of the cessation of wood treatment and sale business operations at the Site Coast Wood Preserving, Inc. ("Performing Settling Defendant") shall submit to the California Department of Toxic Substances Control ("DTSC") a project schedule for review and approval. The project schedule shall include all items listed in this Statement of Work.

2. Update on status of operations at the Site

If within one year from the lodging of this Consent Decree Performing Settling Defendant has not ceased business operations at the Site, Performing Settling Defendant will send a letter to DTSC and to EPA detailing the level of operations that continued at the Site in that year, and a projection of the extent of operations for the next year. This annual report of past year operations and future year operations shall repeat on an annual basis until Performing Settling Defendant ceases business operations at the site and submits the Post Closure Work Plan as specified below.

3. Post Closure Work Plan – Additional Site Characterization.

Ninety (90) days after business operations cease at the Coast Wood Preserving Site, located at the southwest corner of Taylor Drive and Plant Road in the city of Ukiah ("Site"), Performing Settling Defendant shall submit to DTSC and EPA a Post Closure Work Plan for Additional Soil Characterization, consistent with and as provided in the Remedial Cost Estimate. Additional Site Characterization shall include the following:

a) Sampling and Analysis Workplan. The Sampling and Analysis Workplan shall describe the activities, if any, proposed to further characterize soil at the Site. The workplan shall also include the previously approvedSite health and safety plan, quality assurance project plan, sampling plan, and implementation schedule, which plans and schedule shall be modified by Performing Settling Defendant as appropriate.

b) Implementation. Implementation of the approved workplan in accordance with the approved implementation schedule.

c) Soil Characterization Report. The Soil Characterization Report shall include the data, summarize the findings of all prior investigations, and include recommendations and conclusions.

4. Quality Assurance Project Plan ("QAPP").

Performing Settling Defendant shall submit to DTSC the previously approved QAPP, modified by Performing Settling Defendant as appropriate, with, if needed, a Post

Closure Work Plan for Additional Site Characterization. All sampling and analysis shall be performed in accordance with a DTSC-approved QAPP.

5. Health and Safety Plan.

Prior to performing any additional investigation or remedial work at the Site, Performing Settling Defendant shall submit the previously approved Site Health and Safety Plan, modified by Performing Settling Defendant as appropriate, in accordance with California Code of Regulations, title 8, section 5192.

6. Post Closure Work Plan - Soil Excavation (also known as the Remedial Design and Implementation Plan ("RDIP").

Within ninety (90) days of DTSC's approval of the Post Closure Soil Characterization Report, the Performing Settling Defendant shall submit to DTSC a Post Closure Work Plan for Soil Excavation (also known as a Remedial Design and Implementation Plan) describing, in detail, how the Remedial Action Plan will be implemented, and shall include the following:

a) Technical and operational plans and engineering designs for implementation of the approved remedial or removal action alternative(s);

b) A schedule for implementing the construction phase;

c) A description of the construction equipment to be employed;

d) A site specific hazardous waste transportation plan (if necessary);

e) Any required registration requirements for contractors, transporters and other persons conducting the removal and remedial activities for the Site;

f) Post-remedial sampling and monitoring procedures for air, soil, surface water and groundwater;

g) Operation and maintenance procedures and schedules;

h) A health and safety plan; and

i) A community air monitoring plan, if required by DTSC.

7. Implementation of Final RAP.

Upon DTSC approval of the RDIP and schedule, the final RAP shall be implemented as approved in accordance with the approved RDIP and schedule. RAP implementation includes confirmatory soil and groundwater sampling.

8. Changes During Implementation of the Final RAP.

During implementation of the final RAP and RDIP, DTSC may specify such additions, modifications and revisions to the RDIP as deemed necessary to protect human health and safety or the environment or to implement the RAP.

9. Groundwater In-Situ Reductant and Trench Infiltration.

A Groundwater Injection Work Plan shall be prepared using the same format and general content as the previously approved groundwater injection work plans for the Site and be submitted for approval by DTSC before implementation of any additional in-situ groundwater treatment(s). Each treatment event shall be followed by a Groundwater Treatment Report, submitted by Performing Settling Defendant to DTSC for review and comment. A Final Groundwater Completion Report shall be prepared for approval by DTSC when the contaminants in groundwater meet the remedial goals for the Site.

10. Groundwater Monitoring and Sampling and Reporting.

Performing Settling Defendant shall submit to DTSC a semi-annual groundwater monitoring and sampling in conformance with the North Coast Regional Water Quality Control Board's Monitoring and Reporting Program Order No. R1-2012-0055.

11. Public Participation.

a) Performing Settling Defendant shall prepare an updated mailing list for review and approval by DTSC prior to implementation of the approved Post Closure Workplan.

b) On a periodic basis as requested by DTSC, Performing Settling Defendant shall produce appropriate fact sheets for review and approval by DTSC. Fact sheets shall be printed and distributed upon DTSC approval using the approved community mailing list.

c) Work Notices shall be reviewed and approved by DTSC when specifically requested by DTSC. Prior to implementation of the RDIP, following DTSC's approval of the Work Notice, such Work Notice shall be printed and distributed using the approved community mailing list.

12. Land Use Covenant.

As noted in the Consent Decree, a Land Use Covenant ("LUC") has been recorded for portions of the Site. Because additional cleanup will be occurring at the Site, new or revised institutional controls may be appropriate, based on the success of remedy implementation. Under California law, specifically California Code of Regulations, title 22, section 67391.1, if waste remains in place that does not allow for unrestricted use

of the Site, a LUC must be executed and recorded to ensure that use of the Site, as cleaned up under the remedy implemented, will remain protective into the future. Performing Settling Defendant shall prepare, execute, and record new LUC's, or amend the existing LUC as appropriate, to ensure the protectiveness of the remedy in perpetuity. Compliance with California law, including but not limited to, California Code of Regulations, title 22, section 67391.1, the California Health and Safety Code, and California Civil Code section1471, will guide DTSC in determining the institutional controls deemed necessary to ensure full protection of the environment and human health.

13. Operation and Maintenance ("O&M") Plan and O&M Agreement.

Performing Settling Defendant shall submit an O&M Plan that sets forth any and all operation and maintenance requirements for the remedy as implemented in accordance with the final RAP, or a DTSC-approved RDIP. The proposed O&M Plan shall be submitted within ninety (90) days of approval the RDIP. An enforceable O&M Agreement with DTSC may also be required to ensure implementation of the approved O&M Plan.

14. Pre-Certification Inspection, Remedial Action Plan Implementation Report

Within ninety (90) days after Performing Settling Defendant concludes that the Remedial Action has been fully performed and that the Performance Standards have been achieved, Performing Settling Defendant shall schedule and conduct a pre-certification inspection. This inspection will include representatives of Performing Settling Defendant, EPA and DTSC. After the joint pre-certification inspection noted above, and after receiving written comments from DTSC and EPA regarding that inspection, if Performing Settling Defendant believes that the Remedial Action has been fully performed and the Performance Standards have been achieved, Performing Settling Defendant shall request certification by submitting a written report to DTSC for approval, with a copy to EPA, pursuant to Section XI (DTSC Approval of Plans, Reports, and Other Deliverables). Within sixty (60) days of completion of implementation of the RDIP, an Implementation Report documenting the implementation of the final RAP and implementation of the RDIP shall be submitted. This report must note any deviations from the approved plan.

15. Financial Assurance.

As required by the terms of the Consent Decree, and by California Health and Safety Code section 25355.2, Performing Settling Defendant shall demonstrate and maintain adequate financial assurance for remedy implementation, performance of all obligations as set forth in the Consent Decree and this SOW, and for required O&M activities, LUC-related activities, and for Five-Year Review activities following remedy implementation. Financial Assurance will also include amounts necessary for payment of DTSC's incurred costs in overseeing the activities.

16. Five-Year Reviews.

As noted in the National Contingency Plan, a review of the performance of the remedial action shall be completed every five years to determine if the remedy as implemented remains protective. The sixth Five-Year Review is scheduled for 2021. Performing Settling Defendant shall prepare and provide to DTSC and EPA for review all the information necessary for approval of the Five-Year Review, and shall implement the necessary public participation and publication requirements as set forth under federal and state law.

APPENDIX I

Performance Trust Guarantee

TRUST AGREEMENT
Coast Wood Preserving, Inc. Superfund Site
Dated: ________ __, 2017

This Trust Agreement (the "Agreement") relating to [**insert trustee-provided trust account number**] is entered into as of _______ __, 2016 between Coast Wood Preserving, Inc., a California corporation (the "Grantor"), and [**insert name of trustee**], [**insert as appropriate:** "incorporated in the state of [**insert name of state**]" or "a national bank"] (the "Trustee").

Whereas, the California Department of Toxic Substances Control ("DTSC"), and the United States Environmental Protection Agency ("EPA") and the Grantor have entered into a Consent Decree dated __________ __, 2016, Civil Action Number CV-F-96-6055AWI LJO (hereinafter, "Settlement Agreement"), pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 9601-9675;

Whereas, the Settlement Agreement provides that the Grantor shall provide assurance that funds will be available as and when needed for performance of the Work required by the Settlement Agreement;

Whereas, in order to provide such financial assurance, Grantor has agreed to establish and fund the trust created by this Agreement; and

Whereas, the Grantor, acting through its duly authorized officers, has selected the Trustee to be the trustee under this Agreement, and the Trustee has agreed to act as trustee hereunder.

Now, therefore, the Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement*:*

(a) The term "Agreement" shall have the meaning assigned thereto in the first paragraph of this Agreement.

(b) The term "Beneficiary" shall have the meaning assigned thereto in Section 3 of this Agreement.

(c) The term "CERCLA" shall have the meaning assigned thereto in the second paragraph of this Agreement.

(d) The term "DTSC" shall have the same meaning assigned thereto in the second paragraph of this Agreement.

(e) The term "EPA" shall have the meaning assigned thereto in the second paragraph of this Agreement.

(f) The term "Fund" shall have the meaning assigned thereto in Section 3 of this Agreement.

(g) The term "Grantor" shall have the meaning assigned thereto in the first paragraph of this Agreement, along with any successors or assigns of the Grantor.

(h) The term "Settlement Agreement" shall have the meaning assigned thereto in the second paragraph of this Agreement.

(i) The term "Site" shall have the meaning assigned thereto in Section 2 of this Agreement.

(j) The term "State" shall mean the State of California.

(k) The term "Trust" shall have the meaning assigned thereto in Section 3 of this Agreement.

(l) The term "Trustee" shall mean the Trustee who enters into this Agreement and any successor Trustee.

(m) The term "Work" shall have the meaning assigned thereto in the Settlement Agreement.

Section 2. Identification of Site and Cost Estimate. This Agreement pertains to costs for Work required at the Coast Wood Preserving, Inc., Superfund Site in the City of Ukiah, Mendocino County, California (the "Site"), pursuant to the Settlement Agreement.

Section 3. Establishment of Trust Fund. The Grantor and the Trustee hereby establish a trust (the "Trust"), for the benefit of DTSC and/or EPA (the "Beneficiary"), to ensure that funds are available to pay for performance of the Work in accordance with the terms of the Settlement Agreement. The Grantor and the Trustee intend that no third party shall have access to monies or other property in the Trust except as directed by the Beneficiary provided herein. The Trust is established initially as consisting of cash and/or cash equivalents in the amount of $ 9xx,xxx.00, which is acceptable to the Trustee and described in Schedule A attached hereto. Such funds, along with any other cash and/or cash equivalents hereafter deposited into the Trust, and together with all earnings and profits thereon, less any payments or distributions made by the Trustee pursuant to this Agreement, are referred to herein collectively as the "Fund." The Fund shall be held by the Trustee, IN TRUST, as hereinafter provided. The Trustee shall not be responsible nor shall it undertake any responsibility for the amount or adequacy of, nor any duty to collect from the Grantor, any payments necessary to discharge any liabilities of the Grantor established by the Beneficiary.

Section 4. Payment for Work Required Under the Settlement Agreement. The Trustee shall make payments from the Fund in accordance with the following procedures:

(a) From time to time, the Grantor and/or its representatives or contractors may request that the Trustee make payment from the Fund for Work performed under the Settlement Agreement by delivering to the Trustee and DTSC (with a copy to EPA) a written invoice and certificate (together, a "Claim Certificate") signed by an officer of the Grantor (or the relevant representative or contractor). Any Claim Certificate should be in a form substantially identical to the sample provided in Exhibit A and, at a minimum, must contain the following:

(i) Include a certification that the invoice is for Work:
   a. the scope and cost of which has been previouly reviewed and approved in writing by DTSC
   b. performed at the Site in accordance with the Settlement Agreement and the approval of DTSC;

(ii) Describe the Work that has been performed;

(iii) Specify the amount of funds requested from the Trust; and

(iv) Identify the payee(s) of the funds request.

(b) DTSC may object to any payment requested in a Claim Certificate submitted by the Grantor (or its representatives or contractors), in whole or in part, by delivering to the Trustee a written notice (an "Objection Notice") within 30 days after the date of DTSC's receipt of the Claim Certificate as shown on the relevant return receipt. An Objection Notice sent by DTSCshall state (i) whether DTSC objects to all or only part of the payment requested in the relevant Claim Certificate; (ii) the basis for such objection, (iii) that DTSC has sent a copy of such Objection Notice to the Grantor and the date on which such copy was sent; and (iv) the portion of the payment requested in the Claim Certificate, if any, which is not objected to by DTSC. DTSC may object to a request for payment contained in a Claim Certificate only on the grounds that the requested payment is either (x) not for the costs of Work under the Settlement Agreement or previously approved by DTSC or (y) otherwise inconsistent with the terms and conditions of the Settlement Agreement or the DTSC approval.

(c) If the Trustee receives a Claim Certificate and does not receive an Objection Notice from DTSC within the time period specified in Section 4(b) above, the Trustee shall, after the expiration of such time period, promptly make the payment from the Fund requested in such Claim Certificate.

(d) If the Trustee receives a Claim Certificate and also receives an Objection Notice from DTSC within the time period specified in Section 4(b) above, but which Objection Notice objects to only a portion of the requested payment, the Trustee shall, after the expiration of such time period, promptly make payment from the Fund of

the uncontested amount as requested in the Claim Certificate. The Trustee shall not make any payment from the Fund for the portion of the requested payment to which DTSC has objected in its Objection Notice.

(e) If the Trustee receives a Claim Certificate and also receives an Objection Notice from DTSC within the time period specified in Section 4(b) above, which Objection Notice objects to all of the requested payment, the Trustee shall not make any payment from the Fund for amounts requested in such Claim Certificate.

(f) If, at any time during the term of this Agreement, DTSC implements a "Work Takeover" pursuant to the terms of the Settlement Agreement and intends to direct payment of monies from the Fund to pay for performance of Work during the period of such Work Takeover, DTSC shall notify the Trustee in writing of DTSC's commencement of such Work Takeover. Upon receiving such written notice from DTSC, the disbursement procedures set forth in Sections 4(a)-(e) above shall immediately be suspended for costs of Work taken over by DTSC, and the Trustee shall thereafter make payments from the Fund only to such person(s) as the DSTC may direct in writing from time to time for the sole purpose of providing payment for performance of Work required by the Settlement Agreement. Further, after receiving such written notice from DTSC, the Trustee shall not make any disbursements to Grantor for costs of Work taken over by DTSC from the Fund at the request of the Grantor, including its representatives and/or contractors, or of any other person except at the express written direction of DTSC. If DTSC ceases such a Work Takeover in accordance with the terms of the Settlement Agreement, DTSC may so notify the Trustee in writing and, upon the Trustee's receipt of such notice, the disbursement procedures specified in Sections 4(a)-(e) above shall be reinstated.

(g) While this Agreement is in effect, disbursements from the Fund are governed exclusively by the express terms of this Agreement. Resolution of disputes relative to objections to disbursements shall be governed by the dispute resolution provisions of the Settlement Agreement.

Section 5. Trustee Management. The Trustee shall invest and reinvest the principal and income of the Fund and keep the Fund invested as a single fund, without distinction between principal and income, in accordance with general investment policies and guidelines which the Grantor may communicate in writing to the Trustee from time to time, subject, however, to the provisions of this Section. In investing, reinvesting, exchanging, selling, and managing the Fund, the Trustee shall discharge its duties with respect to the Trust solely in the interest of the Beneficiary and with the care, skill, prudence, and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity and familiar with such matters, would use in the conduct of an enterprise of a like character and with like aims; except that:

(a) Securities or other obligations of the Grantor, or any other owner or operator of the Site shall not be acquired or held by the Trustee with monies comprising the Fund, unless they are securities or other obligations of the Federal government or California state government;

(b) The Trustee is authorized to invest the Fund in time or demand deposits of the Trustee, to the extent such deposits are insured by an agency of the Federal government or California state government; and

(c)The Trustee is authorized to hold cash awaiting investment or distribution uninvested for a reasonable time and without liability for the payment of interest thereon.

Section 6. Commingling and Investment. The Trustee is expressly authorized in its discretion to transfer from time to time any or all of the assets of the Fund to any common, commingled, or collective trust fund created by the Trustee in which the Fund is eligible to participate, subject to all of the provisions thereof, to be commingled with the assets of other trusts participating therein

Section 7. Express Powers of Trustee. Without in any way limiting the powers and discretion conferred upon the Trustee by the other provisions of this Agreement or by law, the Trustee is expressly authorized and empowered:

(a) To make, execute, acknowledge and deliver any and all documents of transfer and conveyance and any and all other instruments that may be necessary or appropriate to carry out the powers herein granted;

(b) To register any securities held in the Fund in its own name or in the name of a nominee and to hold any security in bearer form or in book entry, or to combine certificates representing such securities with certificates of the same issue held by the Trustee in other fiduciary capacities, or to deposit or arrange for the deposit of such securities in a qualified central depositary even though, when so deposited, such securities may be merged and held in bulk in the name of the nominee of such depositary with other securities deposited therein by another person, or to deposit or arrange for the deposit of any securities issued by the United States Government, or any agency or instrumentality thereof, with a Federal Reserve bank, but the books and records of the Trustee shall at all times show that all such securities are part of the Fund; and

(c) To deposit any cash in the Fund in interest-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, to the extent insured by an agency of the Federal government or California state government.

Section 8. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund shall be paid from the Fund. All other expenses and charges incurred by the Trustee in connection with the administration of the Fund and this Trust shall be paid by the Grantor.

Section 9. Annual Valuation. The Trustee shall annually, no more than 30 days after the anniversary date of establishment of the Fund, furnish to the Grantor and to the Beneficiary a statement confirming the value of the Trust. The annual valuation shall include an accounting of any fees or expenses levied against the Fund. The Trustee shall also provide such information concerning the Fund and this Trust as DTSC or EPA may request from time to time.

Section 10. Advice of Counsel. The Trustee may from time to time consult with counsel with respect to any question arising as to the construction of this Agreement or any action to be taken hereunder; provided, however, that any counsel retained by the Trustee for such purposes may not, during the period of its representation of the Trustee, serve as counsel to the Grantor.

Section 11. Trustee Compensation. The Trustee shall be entitled to reasonable compensation for its services as agreed upon in writing with the Grantor and as notified in writing to the Beneficiary; provided, however, that the Trustee shall have minimal duties and shall be entitled to minimal compensation, if any, for time periods in which the Trustee does not make payments from the Fund for Work performed under the Settlement Agreement.

Section 12. Trustee and Successor Trustee. The Trustee and any replacement Trustee must not be affiliated with the Grantor. The Trustee may resign or the Grantor may replace the Trustee, but such resignation or replacement shall not be effective until the Grantor has appointed a successor trustee and this successor accepts such appointment. The successor trustee shall have the same powers and duties as those conferred upon the Trustee hereunder. Upon the successor trustee's acceptance of the appointment, the Trustee shall assign, transfer, and pay over to the successor trustee the cash and/or cash equivalents then constituting the Fund. If for any reason the Grantor cannot or does not act in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor trustee or for instructions. The successor trustee shall specify the date on which it assumes administration of the Fund and the Trust in a writing sent to the Grantor, the Beneficiary, and the present Trustee by certified mail no less than 10 days before such change becomes effective. Any expenses incurred by the Trustee as a result of any of the acts contemplated by this Section shall be paid as provided in Section 8.

Section 13. Instructions to the Trustee. All orders, requests, and instructions by the Grantor to the Trustee shall be in writing, signed by such persons as are empowered to act on behalf of the entity sending such orders, requests, and instructions to the Trustee, including those designated in the attached Exhibit A or such other designees as the Grantor may designate by amendment to Exhibit A. The Trustee shall be fully protected in acting without inquiry on such written instructions given in accordance with the Grantor's orders, requests and instructions. All orders, requests and instructions by the Beneficiary to the Trustee shall be in writing, signed by the Beneficiary designees, and the Trustee shall act and shall be fully protected in acting in accordance with such orders, requests and instructions. The Trustee shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor or the Beneficiary hereunder has occurred. The Trustee shall have no duty to act in the absence of such written instructions from the Grantor and/or Beneficiary, except as expressly provided for herein.

Section 14. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor and the Trustee, and with the prior written

consent of DTSC and EPA, or by the Trustee and the Beneficiary, if the Grantor ceases to exist.

Section 15. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided in Section 14, this Trust shall be irrevocable and shall continue until terminated at the written agreement of the Grantor, the Trustee, and the Beneficiary, or by the Trustee and the Beneficiary, if the Grantor ceases to exist. Upon termination of the Trust, all remaining trust property, less final trust administration expenses, shall be delivered to the Grantor.

Section 16. Immunity and Indemnification. The Trustee shall not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this Trust, or in carrying out any directions by the Grantor or the Beneficiary issued in accordance with this Agreement. The Trustee shall be indemnified and saved harmless by the Grantor from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct made by the Trustee in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide such defense.

Section 17. Choice of Law. This Agreement shall be administered, construed, and enforced according to the laws of the state of California.

Section 18. Interpretation. As used in this Agreement, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each Section of this Agreement shall not affect the interpretation or the legal efficacy of this Agreement.

Section 19. Notices. All notices and other communications given under this Agreement shall be in writing, identify the Site, provide a contact person (and contact information), and be addressed to the parties as follows or to such other address as the parties shall by written notice designate:

(a) If to the Grantor, to Mr. Thomas Pike, Attorney, C/O Environmental Liability Transfer, Inc., 1650 Des Peres Road, Ste. 303, St. Louis, MO 63131, PH: 314-835-2801, tpike@cdcco.com.

(b) If to the Trustee, to [**insert name(s), title(s), address(es), and contact information (phone number(s), email address(es), etc.)**].

(c) If to EPA, to [**insert name(s), title(s), address(es), and contact information (phone number(s), email address(es), etc.) of appropriate EPA official/staff (e.g., Superfund Division Director, Remedial Project Manager, and/or Office of Regional Counsel contact)**].

(d) If to DTSC, to [**insert name(s), title(s), address(es), and contact information (phone number(s), email address(es), etc.) of appropriate DTSC official/staff**

(e.g., Deputy Director, Project Manager, and/or Office of Legal Counsel contact)].

Section 20. Other. The Grantor shall provide a copy of the Settlement Agreement to the Trustee, and the Grantor shall submit an originally-signed duplicate of the executed Agreement to EPA.

In Witness Whereof, the parties hereto have caused this Agreement to be executed by their respective officers duly authorized and their corporate seals to be hereunto affixed and attested as of the date first above written:

FOR THE GRANTOR:

Date: ______________	By [signature]:	___________________________
	Printed name:	___________________________
	Title:	___________________________

[Seal of Corporation - Grantor]

State of [**insert state**]
County of [**insert county**]

On this [**insert date**], before me personally came [**insert name of PRP/Settling Defendant's signatory**] to me known, who, being by me duly sworn, did depose and say that she/he is [**insert title**] of [**insert name of PRP/Settling Defendant**], the corporation described in and which executed the above instrument; that she/he knows the seal of said corporation; that the seal affixed to such instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that she/he signed her/his name thereto by like order.

____
[Signature of Notary Public]

FOR THE TRUSTEE:

Date: _____________	By [signature]:	________________________
	Printed name:	________________________
	Title:	________________________

[Seal of Corporation - Trustee]

State of [**insert state**]
County of [**insert county**]

On this [**insert date**], before me personally came [**insert name of Trustee's signatory**] to me known, who, being by me duly sworn, did depose and say that she/he is [**insert title**] of [**insert name of Trustee**], the entity described in and which executed the above instrument; and that she/he signed her/his name thereto.

____
[Signature of Notary Public]

<u>Schedule A</u>
Initial Trust Funding

DATE	FUNDING VALUE FOR WORK
[**Insert relevant initial date (e.g., within 30 days of the Effective Date of the settlement)**]	[**Insert initial funding amount**]

Exhibit A
Grantor-Designated Individuals Authorized for Orders, Requests, and Instructions

[**Grantor to insert person(s) (and relevant contact information) designated to provide/make orders, requests, and instructions to the Trustee pursuant to Section [13] of trust agreement**]

APPENDIX J

Community Relations Plan

MONTGOMERY WATSON

SFUND RECORDS CTR
2291819

May 13, 1999

Ms. Rachell Maricq
California Environmental Protection Agency
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710

Subject: Coast Wood Preserving, Ukiah, California
RAP Amendment

Dear Ms. Maricq:

This letter serves to transmit the draft revised Community Relations Plan (CRP) for the Coast Wood Preserving (CWP) site. As discussed in my phone message to you, we understand that Allan Lui of DTSC submitted information to the DTSC CEQA staff on April 26, 1999 for a negative declaration regarding the proposed *Amendment to the Remedial Action Plan* prepared for the site. We are also in the process of preparing a fact sheet, which provides information about the site and the proposed RAP Amendment and announces the required 30 day comment period. The draft fact sheet should be available next week for your review.

Please coordinate the schedule of your review of these documents with Robert Feather of DTSC. Please call either Bob Schmidt of CWP at (209) 632-9931 or me at (925) 975-3436 if you have any questions or comments.

Sincerely,
MONTGOMERY WATSON

Richard Thomasser

Richard M. Thomasser, REA,RG
Principal Hydrogeologist

c: Jan Goebel, RWQCB
Penny McDaniels, USEPA
Jim Rouse, Montgomery Watson
CWP

Coast Wood Preserving Site
Ukiah, California

Community Relations Plan

Revised May 12, 1999

Prepared for:
Coast Wood Preserving
Ukiah, California

Prepared by:
Montgomery Watson
1340 Treat Blvd., #300
Walnut Creek, California 94596

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Appendices

1.0 INTRODUCTION

This revised Community Relations Plan (CRP) describes the community relations program that Coast Wood Preserving, Inc. (CWP) plans to implement during the Remedial Action (site cleanup) activities at the Coast Wood Preserving (Coast Wood) site in Ukiah, California. The purpose of the community relations program is to inform community members and other interested persons about the cleanup process, as well as to encourage communication between the Ukiah community, the regulatory agencies, and CWP. The State of California Department of Substance Control (DTSC) is overseeing the remedial action and will oversee community relations activities at the site. The Regional Water Quality Control Board (RWQCB) North Coast Region is also involved with site cleanup, surface water and groundwater monitoring and sampling.

The original Community Relations Plan was based on information gathered in interviews with representatives of the City of Ukiah, Mendocino County, local businesses, community groups, and interested citizens. These interviews were conducted in Ukiah in July 1987. This revised plan incorporates site historical information and provides updated information regarding the current site activities and plans.

Also included in this plan are two appendices: Appendix A is an updated mailing list for the site that includes community members, elected officials, and agency representatives. Appendix B provides the locations for information repositories and public meetings to be held in Ukiah.

The DTSC contact for the site is Robert Feather. He can be reached by telephone at (510) 540-2122. The RWQCB contact for the site is Jan Goebel. She can be reached by telephone at (707) 576-2220.

2.0 SITE HISTORY

The Coast Wood site is located in Medndocino County, California, approximately two miles south of the city of Ukiah (see Figure 1). The site is bounded by U.S. highway 101 on the west, Taylor Drive on the east, Plant Road on the north, and by agricultural lands to the south. The Coast Wood site is approximately one-half mile west of the Russian River. The river supports major beneficial uses in Northern California, including domestic water supplies, agricultural water supplies, fish habitats, wildlife habitats, and recreation activities. Two tributaries of the Russian River flow through the Coast Wood facility.

The primary activity at the Coast Wood facility is wood preserving. Since 1971, Coast Wood has been treating timber products with a preservative comprised of sodium dichromate, copper sulfate, and an arsenic acid commonly known as CCA. In May of 1999, CWP switched to using a premix of CCA oxides instead of the aforementioned

chemical salts. Wood is pressure-treated with CCA and then stored on-site along with wastes from the treatment process and treatment chemicals.

Regulatory agencies have been involved in activities at the Coast Wood site since the early 1970's. In April 1972, the RWQCB first established waste discharge requirements for Coast Wood. The requirements prohibited Coast Wood from discharging wood treatment chemicals to surface or groundwater. Just before establishing these requirements, the RWQCB issued a Cleanup and Abatement Order to Coast Wood requiring it to stop discharges of chromium, copper, and arsenic that had been observed in storm water runoff. In January 1973, the Mendocino County Superior Court ordered Coast Wood to provide enough storage space to retain any contaminated rainwater runoff. Coast complied with this order by paving areas where lumber dripped, installing a storage tank and recycling system, and expanding waste and chemical storage areas.

The Coast Wood facility expanded significantly in the mid-1970s. Sampling by the RWQCB in the winter of 1980-81 indicated that wood treating chemicals were again being discharged to surface water. Concerned that these discharges might have contaminated groundwater supplies, the RWQCB requested Coast Wood to develop a plan for investigating possible groundwater contamination. In March 1981, the RWQCB established a schedule of interim action for Coast Wood to take in order to stop the release of contamination to surface and groundwater. In September 1981, Coast Wood submitted a study that reported chromium in monitoring wells under the plant.

The RWQCB referred the case to the State Attorney General in September 1981. Later that year, the RWQCB used emergency cleanup funds to drill five wells beyond the site property; results from these wells indicated that contamination also was present in off-site locations. In December 1981, the Mendocino Superior Court ordered Coast Wood to comply with the RWQCB order. The company installed a 300,000 gallon holding tank, a system to collect water for reuse, and roofs over treated lumber storage areas.

From 1982 to 1987, Coast Wood conducted studies to determine more precisely the extent of groundwater contamination. Reports submitted by Coast Wood to the RWQCB and DTSC showed that soil and groundwater on the site property were contaminated with chromium. A narrow plume of chromium in groundwater extending southeast in the direction of the river was identified. Hexavalent chromium, the type of chromium identified at the Coast Wood site, is less stable than other forms of chromium and also is more toxic. While small amounts of chromium are essential to the human diet, exposure to significant amounts of chromium can lead to skin irritation, and respiratory system damage. The Environmental Protection Agency (EPA) and the International Agency for Research on Cancer have determined that hexavalent chromium, when inhaled, can be a human carcinogen. Chromium also is on the California list of chemicals known to cause cancer or reproductive toxicity, developed by the Governor under the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).

In October 1983, Coast Wood constructed a slurry wall, an underground barrier, along the eastern boundary of the facility property to intercept the chromium plume. In

addition, the entire facility has been paved with asphalt, and berms, designed to control the flow of liquid within a specific area, have been installed at the site to catch all runoff and storm water. This prevents contamination from exiting the site as surface runofff. In 1983, the Coast Wood site was listed on the federal National Priorities List (NPL).

In January 1984, after a public hearing, the RWQCB issued a Cleanup and Abatement Order. Under the terms of the Order, Coast Wood submitted to DTSC a work plan for cleaning up contaminated soils at the site. In June 1985, at the request of DTSC, the RWQCB, and EPA, Coast Wood submitted a plan for controlling groundwater contamination at the site. The agencies allowed Coast Wood to implement its plan. The plan involves extracting groundwater and either a) recycling the water for use in wood preserving operations, or b) treating it by an electrochemical process to reduce chromium concentrations below detectable levels. After treatment, the water is reinjected into the groundwater at the plant site. In addition, the plan called for the continued use of the slurry wall to prevent the groundwater contamination plume from spreading.

During the 1980s, Coast Wood and the agencies worked to define the extent of contamination in the site area and develop long-term cleanup solutions. Because the site is being addressed by DTSC and EPA under both state and federal programs, the solution to the problem must meet the requirements of the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or "Superfund"). Progress at the site also is being monitored by the National Oceanographic Atomospheric Administration (NOAA), the California Department of Fish and Game, the Mendocino County Health Department, and the City of Ukiah, who are concerned about the potential impact of contamination on the Russian River. In the fall of 1987, Coast Wood submitted a Remedial Action Plan (RAP), or long-term cleanup proposal, to the RWQCB, DTSC, and EPA. The draft RAP was submitted to the public for a thirty-day review and comment period.

The final, approved *Remedial Action Plan* (Geosystem, 1989) includes the aforementioned abatement measures such as controlling storm water run-off and reusing process water, as well as active remediation in the form of extraction and subsequent treatment of groundwater (pump and treat). CWP has implemented all of the remedial action elements prescribed by the RAP with the exception of on site treatment of impacted soils using best available technology. When the RAP was approved in 1989, soil remediation was to be evaluated upon termination of the wood treating operations because it was deemed technically impractical to fully address soil while the plant continues to operate. Currently the plant is still in operation, and no closure date has been forecast by CWP.

3.0 CURRENT SITE STATUS

The remedial measures referenced above have been effective in limiting further impact to the soils and groundwater at the site by the continuing wood preservation operations. The most effective measures have been the abatement measures which have significantly limited the potential for further impact to the subsurface. In addition, the slurry cut-off wall in

conjunction with groundwater extraction has caused a marked decrease in the extent of the plume. A comparison of the size of the plume from January 1986 to November 1998 illustrates a decrease of approximately 60 percent. The effectiveness of the remedial measures on reducing the mass/concentration of dissolved chromium is not as dramatic or obvious. A review of the available data shows fluctuations in the reported concentrations of up to an order of magnitude.

CWP has proposed to amend the RAP and the existing site cleanup activities using recent technology enhancements for the treatment of chromium in soil and groundwater. The proposed *Remedial Action Plan Amendment*, (Montgomery Watson, 1999) addresses technology enhancements that can address groundwater impacts as well as soil impacts at the site while the plant is in operation.

This Community Relations Plan has been revised and updated in consideration of public involvement during the approval process of the RAP Amendment.

4.0 COMMUNITY BACKGROUND

4.1 Community Profile

The Coast Wood site is located just south of the City of Ukiah in Mendocino County, California. The Mendocino County area has traditionally relied on lumber and agriculture for its economic base. Tourism is also important to the area's economy. The area around Ukiah, the County seat, has a population of about 30,000 people. Coast Wood is one of many lumber facilities in the Ukiah area.

According to local officials and community members, awareness of environmental issues in Mendocino County is fairly high. Many County residents work in the lumber and agriculture industries. In addition, the County has an active group of environmentalists who have established an Environmental Center in Ukiah.

4.2 History of Community Involvement

According to the original CRP, community involvement at the Coast Wood site began with several Regional Board hearings held periodically between 1981 and 1986. In that time period a number of people from the Ukiah area telephoned and wrote letters to the Regional Board expressing concern about the contamination problems at the site and potential impacts on the Russian River. A few Ukiah residents attended the Board hearings, most of which were held about sixty miles south of Ukiah in Santa Rosa. In addition, water purveyors and cities south (downriver) from Coast Wood submitted letters to the Regional Board and attended hearings to express their concern about the impact of contamination on water quality in the Russian River.

In the summer of 1986, the Mendocino County Planning Department received inquiries about the Coast Wood site from the Ukiah Board of Realtors (UBR). A representative from the UBR reports becoming aware of the site when a local realtor was informed that construction in the immediate area of the site was restricted. In an effort to learn more about this reported building restriction and its ramifications on realtors in terms of disclosure requirements to potential property buyers, the UBR contacted the Planning Department. The Planning Department in turn contacted DTSC in Sacramento to find out more about the notification procedures that must be followed when a permit is filed. After exchanging letters and telephone calls for several months, Planning Department representatives and the Board of Realtors participated in a company-sponsored tour of the Coast Wood facility.

County officials reported having received inquiries about the Coast Wood site during the period that the site has been under regulatory agency review. Officials said that calls were infrequent in the past few years.

Most individuals contacted in preparing the original CRP perceived that the Coast Wood site has attracted relatively little attention in the community when compared with other environmental issues in the County. An issue cited by several people contacted for this plan occurred in 1985, when members of the Ukiah community opposed a proposal by the city and the Northern California power Agency to build a turbine power plant in the area. A coalition of individuals from civic and environmental groups requested that an Environmental Impact Statement be prepared. The plant was eventually constructed elsewhere. One of the outcomes of the power palnt issue was the establishment by the city of an electrical energy conservation committee that studied the economic impacts of energy conservation practices in Ukiah. City officials report that the city is collecting data to implement the study's recommendations in the future. Another outcome of the power plant issue was the formation of Citizens for Adequate Review (CIFAR). This citizens' action group is interested in helping the County examine and rewrite air pollution regulations.

Other issues cited as important in the area by the people interviewed for the original CRP included offshore oil drilling, clearcutting of forests, and spraying apple orchards with pesticides to eliminate apple maggots. Environmental activists report that they are concerned about potential contamination and groundwater problems at wood-treating facilities throughout the county. The Regional Board reported that a survey conducted in the Russian River area of facilities which might have use, stored, or disposed of toxic chemicals had shown little interest in the Ukiah area, despite extensive public participation efforts by the Board.

In recent years, most community involvement regarding the Coast Wood site has occured when the RWQCB is reviewing changes to the plants permits.

4.3 Key Community Issues and Concerns

The following community issues and concerns were expressed to DTSC representatives in interviews with local government officials, agency representatives, members of community groups, and residents as part of preparation of the original CRP. The issues and concerns presented here provide the basis for the next section: Highlights of the Community Relations Program at the Coast Wood Site.

- Potential impact of contamination on the Russian River and surrounding areas. The Russian River is the drinking water source for about one-half million people in Mendocino and Sonoma counties. In addition, the river is used for agriculture, recreational purposes, and food sources. Since the Regional Board issued its first Enforcement Order to Coast Wood in 1981, community members, government agencies, and downstream water purveyors and jurisdictions have written letters and attended meeting to express their concern about the possibility of contamination from the Coast Wood site reaching the river. Some agency officials contacted during preparation of the plan expressed a lesser degree of concern about the potential impact of contamination on residences and orchards located near the site. Individuals who have a working knowledge of actions taken to date to stop the contamination are pleased that measures have been taken to mitigate the problem, although some community members expressed concern about the effectiveness of these measures.

- Need for more information about the Superfund program and how it relates to the Coast Wood site. The Coast Wood site is the first Superfund site in the County. Most people in Ukiah, including elected officials, agency representatives, and community members, expressed interest in learning more about the Superfund program and process. Environmental and civic groups, County agencies, elected officials, and business organizations had questions for DTSC representatives about the timeframe for site cleanup, the roles and responsibilities of involved agencies and parties, requirements for disclosure and future liability associated with Superfund sites, and other Superfund site with similar problems in the State.

  Many individuals contacted in preparation of the original CRP expressed the need for better information about the site. These people said they were unsure about the precise nature of the problem and any threats posed by the site to public health. Some representatives from government agencies and environmental groups said they had encountered difficulty in the past in obtaining information about the site from DTSC and the Regional Board.

- Impact of the site on economic development. Some members of the business community said that their level of concern about the site, which is presently low, would likely increase should the site have adverse effects on the area's economy. These individuals pointed out that Coast Wood, while important to the local

economy, is not a primary employer in the area; they added that if the site were one of the larger lumber companies in Ukiah, the level of concern would be significantly greater.

- Effectiveness of cleanup measures and their impact on the environment. Elected officials and members of environmental organization had questions about how the water collection system that Coast Wood has installed at the site works. Several people questioned the effectiveness of the system. In particular, environmentalists wondered whether the electro-chemical process to remove contaminants from runoff and waste water creates air pollution problems by releasing the contaminants into the air. These people believed that the process involved an air stripping tower.

- Impact of Proposition 65 on site cleanup standards. A representative of one elected official asked how Proposition 65, a ballot initiative approved by California votes in November 1986, will impact cleanup at the site. Proposition 65 requires the establishment of cleanup standards for a list of chemicals established by the governor. This individual questioned what the cleanup target levels for heavy metals would be at Coast Wood.

5.0 COMMUNITY RELATIONS PROGRAM

Regulatory agencies have been working with Coast Wood for several years to address the contamination problems at the site. The community relations program addresses the concerns expressed by the Ukiah community and neighboring jurisdictions while informing the community about upcoming site-related issues and activities. Keeping this information in mind, the primary objective of the community relations program for the site will be to establish three-way communication between Coast Wood, agency project staff and community members. Other objectives include informing the community about the Superfund process and the Coast Wood site, and providing accurate, timely and easily-accessible information about site-related activities to interested community members. These objectives, and the actions that will be taken to fulfill them, are described below.

5.1 Community Relations Objectives

- Establish three-way communication between Coast Wood agency project staff and community members. An integral part of the Superfund program is to establish a dialogue between the community potentially affected by or interested in a Superfund site and the agency staff and others involved in the investigation and subsequent cleanup of the site. The first step in ensuring that such opportunities for dialogue occur at the Coast Wood site was the community assessment interviews that were the basis for developing the original CRP. DTSC will continue this dialogue by responding to information needs identified.

CWP will hold public meetings as required by law whenever changes occur with respect to the remedy being implemented at the site. In addition, the State requires that the draft RAP amendment be available for public review for a minimum of 30 days. The RAP amendment will be placed in the information repository.

- Inform the community about the Superfund process and the Coast Wood site. DTSC will provide the community with basic information about the State Toxics program such as how the program is funded, and the steps involved in site investigation and cleanup. DTSC also will provide the community with a description of site activities and a summary of the regulatory agency actions. This information can be included in a fact sheet that will be distributed to the community prior to the release of the draft RAP amendment for public comment.

  As the cleanup proceeds, the community will be provided with information updates. All informational materials will be mailed to individuals on the mailing list that has been established for the site. Informational materials and site-related documents also will be placed in the information repository located in the Mendocino County library in Ukiah.

  Because the Ukiah community has an awareness of and interest in environmental issues, it is expected that community members may have questions not directly related to the Coast Wood site. DTSC representatives will be prepared to provide community members with available information on other environmental issues and topics. In addition, DTSC will refer questions it cannot answer to the appropriate individuals or agencies. Placing a list of such agencies and individuals in the site information repository will be important to the success of the community relations program for the Coast Wood site.

- Provide accurate, timely, and easily-accessible information about site-related activities to interested community members. In addition to preparing fact sheets and updates providing background information and site-related activities, site-related reports and documents will be made available to community members. All such materials will be placed in the information repository located in the Mendicino County library in Ukiah.

5.2 COMMUNITY RELATIONS ACTIVITIES

Recommended DTSC community relations activities for the Coast Wood site are listed below as they correspond to remedial technical milestones. An overall schedule is provided in Figure 2.

Technical Milestones	Community Relations Activities
1. During the Remedial Investigation (RI)	• Establish mailing list • Establish information repository
2. Upon Completion of Draft Remedial Action Plan (RAP)	• Prepare fact sheet summarizing site history, RI findings, draft RAP, and Superfund program • Provide public comment period on draft RAP • Announce availability of RAP and public comment period through news releases and community publications • Hold public meeting to receive comments on proposed alternatives • Respond to comments received on draft RAP
3. Upon Completion of Final RAP	• Notify meeting participants and mailing list of selected alternative • Update information repository with Final RAP
4. Prior to Implementation of RAP	• Update mailing list • Revise Community Relations Plan
5. During Remedial Action	• Maintain updated mailing list • Revise Community Relations Plan to address any changes to the remedial action program • Hold public meetings to keep community appraised of activities at the site.

Shaded area reflects completed activities.

Figure 2
Schedule of Community Relation Activities at the Coast Wood Preserving Site
Ukiah, California

	Technical Milestones			
Community Relations Activities	**During Remedial Investigation (RI)**	**Upon Completion of Draft Remedial Action Plan (RAP)**	**Upon Completion of Final RAP**	**Future Events**
Information Repository	--------------------Reports included as available--------------------			
Mailing List (update as needed)	--------------------Ongoing--------------------			
Designate Central Contact Person				
Fact Sheets		X		X
Updates			X	X
Public Comment Period (minimum 30 days)		X		X
Public Meeting		X	X	X
Responsiveness Summary			X	
Revise Community Relations Plan as needed				X

Appendix A
List of interested Parties and Contacts

A. Federal Elected Officials

Senator Dianne Feinstein 415.536.6868
525 Market Street Suite 3670
San Francisco, CA. 94105

Senator Barbara Boxer 415.403.0100
1700 Montgomery Suite 240
San Francisco, CA. 94111

House of Representatives – 1st District
Mike Thompson 707.962.0933
P O Box 2208
Fort Bragg, CA. 95427

B. State Elected Officials

Senator – Chesboro 707.468.8914
P O Box 785
Ukiah, CA. 95482

Assemblywoman Virginia Strom Martin 916.319.2001
104 West Church Street
Ukiah, CA. 95482

C. Local Officials

Michael Delbar, Supervisor 707.463.4221

D. State and Local Agencies

City of Ukiah – Administration 707.463.6200

Ukiah Valley Fire District
1500 S. State Street
Ukiah, CA. 94582

County of Mendocino Environmental Health
501 Low Gap Road, Room 1326
Ukiah, CA. 94582
John D. Rogers 707.463.4466

"Hazardous Materials" – Roger Foote 707.463.5425

E. **Community Organizations**

CATS
P O Box 1195
Arcada, CA. 95518
Patty Cleary

Mendocino Environmental Center
106 W. Standley Street
Ukiah, CA. 94582
Betty Ball

F. **Citizens and Other Interested Parties**

Sonoma County Water Agency
P O Box 11628
Santa Rosa, CA. 95406-1628

Cordes Langley
Coast Wood Preserving
P O Box 723
Ukiah, CA. 94582

Mitchell Namura
SANWA Bank
444 Market Street, 23rd Floor
San Francisco, CA. 94111

Bart Van Voorhis
P O Box 311
Redwood Valley, CA. 94570

Bob Schmidt
Coast Wood Preserving, Inc.
P O Box 1805
Turlock, CA. 95381

Julia Hicks
Redwood Health Club
3101 S. State Street
Ukiah, CA. 94582

Mr. Harold Logsdon
Coast Wood Preserving, Inc.
P O Box 1805
Turlock, CA. 95381

Rick Thomasser
Montgomery Watson
1340 Treat Blvd., Suite 300
Walnut Creek, CA. 94596

Gene Pietila
Coast Wood Preserving
P O Box 723
Ukiah, CA. 94582

Dan Thomas
P O Box 748
Ukiah, CA. 94582

Timothy McDonald
Geological Technics, Inc.
2741 River Road
Modesto, CA. 95351-4907

G. Media

Ukiah Daily Journal 468.3500
P O Box 749
Ukiah, CA. 94582
Glenda Anderson

Anderson Valley Advertisor 895.3016

H. Regulatory Agencies

US EPA
Source Water Protection Section
Drinking Water Protection
Water Management Division
75 Hawthorne Street
San Francisco, CA. 94105
Milton Moraly (W-6-3)

Appendix B
Suggested Information Repository and Meeting Locations

Suggested Information Repository

Mendocino County Library
105 N. Main Street
Ukiah, CA. 95482
707.463.4491
Contact: Pat Hunt, Reference Librarian

Suggested Meeting Locations

Mendocino County Health Department Confrence Room
880 N. Bush Street
Ukiah, CA 95482
707.463.4461
Contact: John D. Rogers
Capacity : 50 People

Little Theater
Ukiah High School
1000 Lone Gap Road
Ukiah, CA 94582
707.463.5253
Contact: Maricela Zamora
Capacity: 500-800 People

1316-00322

MONTGOMERY WATSON

June 4, 1999

Mr. Mark Piros
California Environmental Protection Agency
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710

Subject: Coast Wood Preserving, Ukiah, California
Final Proposed RAP Amendment

Dear Mr Piros:

This letter serves to transmit the final Proposed RAP Amendment for the Coast Wood Preserving (CWP) site. As discussed, the document is being sent to the information repositories for public comment between June 7 to July 6, 1999.

Also enclosed are copies of the Public Notice that will Post in the Ukiah Daily Journal on Monday June 7, 1999 and the Fact Sheet that will be mailed to the approved mailing list on June 4, 1999. The CWP site mailing list is also enclosed.

Please call either Bob Schmidt of CWP at (209) 632-9931 or me at (925) 975-3436 if you have any questions or comments.

Sincerely,
MONTGOMERY WATSON

Richard Thomasser

Richard M. Thomasser, REA,RG
Principal Hydrogeologist

c: Jan Goebel, RWQCB
Penny McDaniels, USEPA
Jim Rouse, Montgomery Watson
CWP, Ukiah and Turlock Offices
Pat Hunt, Mendocino County Public Library Reference Desk

Enclosures

FACT SHEET

COAST WOOD PRESERVING SUPERFUND SITE
UKIAH, CALIFORNIA

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY **MAY 1999**

COAST WOOD PRESERVING PROPOSES REMEDIAL ACTION PLAN AMENDMENT

Introduction

This Fact Sheet provides information about continued environmental cleanup activities at the Coast Wood Preserving (CWP) Site in Ukiah, California. In response to improvements in cleanup technologies and to enhance the cleanup actions at the site, CWP proposes to amend the Remedial Action Plan (RAP) established for the site. The proposed amendment involves incorporating a technology known as *in-situ* geochemical fixation into the cleanup program at the site.

The original RAP was approved by the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) in September 1989. A 30-day public comment period is required under the California Environmental Quality Act before DTSC can approve the proposed amendment to the RAP. The public is encouraged to review and comment on the proposed RAP Amendment during the public comment period from June 1 through July 1, 1999. A copy of the RAP Amendment and other site reports is available for review at the Ukiah Public Library. In addition, the public is invited to attend a public meeting at the Ukiah Community Center on June 23, 1999.

Site Background

The CWP site is located at the intersection of Taylor and Plant Roads in the city of Ukiah (see Figure 1). CWP has used the site for wood preserving operations utilizing copper, chromate and arsenic solutions since 1971.

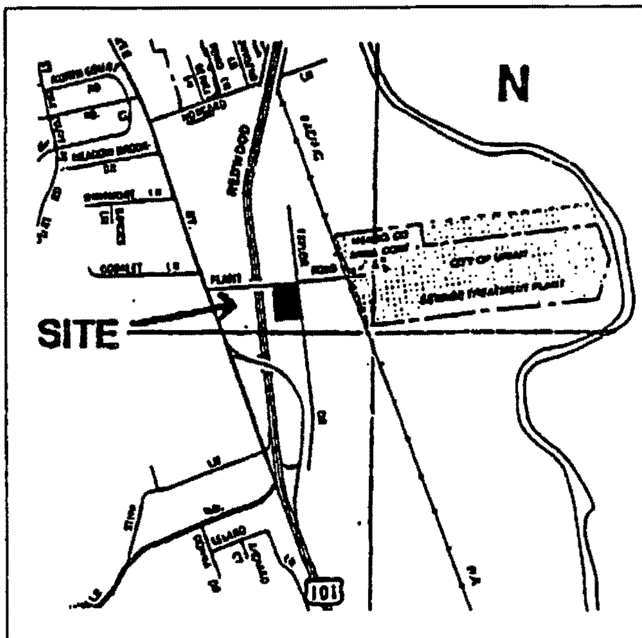

Figure 1: Site Location

In the early 1980's, groundwater impacts related to these operations were observed. Several phases of investigation and cleanup have been conducted to characterize and address impacts to soil and groundwater.

Current Site Cleanup Activities

The selected cleanup activities as presented in the RAP include abatement measures such as controlling storm water run-off and reusing collected water as process water, as well as active cleanup in the form of extraction and treatment of groundwater. CWP is currently implementing the cleanup activities selected by the RAP with the exception of active treatment of the soils since CWP is still performing wood treatment operations.

These cleanup activities have been effective in limiting further impact to the soils and groundwater at the site. In addition to the groundwater extraction outlined above, CWP installed a cutoff wall/recovery trench near the southeastern (downgradient) boundary of the site to further limit the migration of impacted groundwater. These measures have been effective in controlling the migration of hexavalent chromium in the groundwater. However, the levels of hexavalent chromium detected in the groundwater remain relatively constant. Based on experience with similar sites underlain with inter-bedded fine-grained soil, the current actions will require many years to reach cleanup levels.

In-Situ Geochemical Fixation

In-situ (in place) geochemical fixation is a proven and innovative technology for the cleanup of chromium-impacted soil and groundwater. Experience with this technology has shown a significant reduction in the time required to reach cleanup levels as compared to conventional pump and treat approaches alone. Chemically reducing the hexavalent chromium in place allows the use of natural groundwater flow dynamics as well as naturally occurring physical processes to augment the cleanup of the soil and groundwater. This technology has shown a significant and lasting effect on the impact of hexavalent chromium in groundwater and soil at other wood preserving sites.

This technology has been tested and implemented at several sites in the United States and abroad. The technology includes the use of a chemical reductant to reduce hexavalent chromium, which is highly soluble (therefore relatively mobile in groundwater), to trivalent chromium which is relatively insoluble. Additionally, hexavalent chromium is considered toxic and carcinogenic, whereas trivalent chromium is considered non toxic. The amount of chromium added to the soil by the fixation of trivalent chromium is insignificant when compared to background (naturally occurring) levels of chromium and does not represent a threat to human health or the environment.

Cleanup programs at other similar wood preserving sites in California are implementing this technology under approval by the Regional Water Quality Control Board (RWQCB) and the US EPA. Locally (North Coast RWQCB region), a cleanup program is being conducted at a wood treatment facility in Windsor, California. The *in-situ* fixation technology was initiated at the site in 1996 in the shallow groundwater and soil. There has been a reduction in the size of the area impacted by hexavalent chromium in groundwater at this site of approximately 75%. The soil treatment at the Windsor site has shown a similar effect.

Conceptual Approach

Based on the geologic conditions encountered at the CWP site, direct pressure injection of reductant into impacted portions of the shallow groundwater zone is anticipated to provide the best results in achieving remedial objectives for groundwater. The existing pump and treat remedial action elements will continue as set forth in the RAP. The approach to address both soil and groundwater impacts is discussed below.

Soil
Soil moisture (pore water) samples will be collected from locations which are reported to have elevated concentrations of chromium detected in the soil. If the results of these samples indicate that there is mobile hexavalent chromium within the vadose zone in the source areas, direct application of reductant into the vadose zone is the most successful method of treatment. Based on experience at similar wood preserving sites, the most effective delivery method is via infiltration galleries. These galleries are constructed by trenching throughout the source area to approximately 3 feet in depth and backfilling the trenches with permeable material, and infiltrating reductant directly into the vadose zone. Due to active wood treatment operations, it may not be practical to install these galleries in certain areas of the site at this time.

Groundwater
As stated above, direct injection of reductant into impacted portions of the shallow groundwater zone is proposed. The direct injection will be accomplished using a Geoprobe™ rig to push 3/4-inch injection pipes to a target depth (approximately 15 feet) at each location (actual locations to be determined based on site conditions). At each location, the pipes will be withdrawn 5 feet and a calculated volume of reductant will be injected using a piston pump. Following the reductant, a calculated volume of water will be injected at each of the locations to assist in dispersing the reductant solution. Once injected, the reductant will come into contact with residual hexavalent chromium and achieve reduction of hexavalent chromium to the trivalent form, followed by the sorption of the trivalent chromium onto soils in the groundwater zone. The amount of trivalent chromium that will sorb onto the soil is estimated to increase chromium concentrations by approximately 5% in comparison to the existing background values of trivalent chromium in the soil. The trivalent chromium sorbed onto the soil is highly insoluble thus eliminating the threat of continued groundwater impact. The residual chromium levels will pose no threat to human health or the environment.

The existing downgradient extraction well will continue to be pumped to maintain hydraulic control of the plume and aide in dispersion of the reductant throughout the impacted area of the site. As the reductant front migrates through the aquifer from points of injection toward monitoring wells and the extraction well, water quality parameters will be monitored to evaluate cleanup progress. Groundwater extraction will continue until chromium concentrations decline to below the applicable State of California Maximum Contaminant Level (MCL) of 0.05 mg/L dissolved chromium.

Groundwater Monitoring

The routine groundwater monitoring and sampling program which CWP currently executes will continue as required by the RWQCB. Additionally, prior to beginning the direct injection, as a baseline, groundwater samples will be collected from all appropriate onsite monitoring wells. The groundwater samples will be analyzed for total dissolved chromium and sulfate. After the injection event, select wells will be sampled monthly and quarterly. Six months and one year following the injection event, all the appropriate wells on site will be sampled again.

Lysimeters installed to evaluate the presence of residual hexavalent chromium in soil moisture in the vadose zone will be sampled quarterly during the first year after installation. Continued monitoring will be based on the results. Samples will be collected for total dissolved chromium analysis.

California Environmental Protection Agency
Derpartment of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710

Place Address Label Here

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The public is invited to attend a meeting regarding proposed changes to the environmental cleanup program at the Coast Wood Preserving Superfund Site in Ukiah, California (see details inside). The changes are being proposed to enhance the current cleanup activities. All interested parties are encouraged to attend.

In addition, a 30 day public comment period from June 1-July 1, 1999 is being held by the California Environmental Protection Agency.

For More Information or to Comment Contact:

California Environmental
Protection Agency
Department of Toxic
Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710

Robert Feather
Site Manager
(510) 540-3804

Rachell Maricq
Public Participation Coordinator
(510) 540-3910

PUBLIC MEETING

June 23, 1999
7:00 PM

Mendocino County Health Department Conference Room
880 N. Bush Street
Ukiah, California 95482
(707) 463-4461

INFORMATION REPOSITORY:
(to review site reports)

Mendocino County Public Library
105 N. Main Street
Ukiah, California 95482
(707) 463-4491

1316-00322

PUBLIC NOTICE

PUBLIC COMMENT PERIOD AND PUBLIC MEETING
PROPOSED REMEDIAL ACTION PLAN AMENDMENT
AND A
PROPOSED NEGATIVE DECLARATION

Coast Wood Preserving Superfund Site
Plant and Taylor Roads, Ukiah, California

The California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), requests public comments on proposed documents relating to remediation activities at the Coast Wood Preserving Superfund Site in Ukiah, California. These activities include soil and groundwater cleanup related to impacts from wood treatment operations at the site.

The proposed documents are:

- A proposed Remedial Action Plan (RAP) Amendment, which proposes to add a technology known as *in-situ* geochemical fixation into the cleanup program at the site. The cleanup plan (RAP) was approved in 1989 and has been implemented since that time.

- A proposed Negative Declaration, prepared by DTSC under the provisions of the California Environmental Quality Act. The proposed Negative Declaration finds that implementing the RAP Amendment would not result in significant adverse environmental impacts.

DTSC will accept comments on these documents during a **public comment period**, which begins on June 7, 1999, and ends on July 6, 1999. All written comments should be sent to Mark Piros, DTSC Project Manager at the address shown below:

The full Administrative Record pertaining to this matter is available for public review at the DTSC File Room located at:

California Environmental Protection Agency
Department of Toxic Substances Control (DTSC), Region 2
700 Heinz Avenue, Suite 200, Berkeley, California 94710-2737
(510) 540-3800

You can review the proposed RAP Amendment and proposed Negative Declaration, along with other site-related documents at the address above or at the following location:

Mendocino County Public Library
105 N. Main Street
Ukiah, CA 95482

A **public meeting** will be held on June 23, 1999 at the Mendocino County Board of Supervisors - Board Chambers – 501 Low Gap Road, Ukiah at 7:00 PM to discuss the proposed RAP Amendment and Negative Declaration and to receive public comments. All interested parties are encouraged to attend.

At the close of the public comment period, DTSC will carefully consider all public comments received and make a final decision on the proposed RAP Amendment and proposed Negative Declaration. All commentors will be notified of the decision and will receive a copy of the response to comments. A copy of the response to comments will also be available in the information repositories at the above addresses.

If you have any questions regarding this project please contact either Mark Piros, Project Manager at (510)540-3832 or Rachelle Maricq, Public Participation Coordinator at (510)540-3910.

COAST WOOD PRESERVING
UKIAH, CALIFORNIA

FACT SHEET MAILING LIST

Rebecca Hull

348 Harris Avenue
Rodeo, CA 94572

Ron Baker
Cal/EPA DTSC Sacramento Ofc.
10151 Croydon Way
Sacramento, CA 95827

John Kopchik
Contra Costa Co. Fish & Wildlife Cm
651 Pine Street, North Wing, 4th Fl
Martinez, CA 94553-0095

Amador Lima

5630 Airline Highway
Hollister, CA 95023

Larry Woodson
Cal/EPA DTSC Sacramento Ofc.
10151 Croydon Way
Sacramento, CA 95827

Jane Williams
Desert Citizens Against Pollution
3813 50th Street West
Rosamond, CA 93560

William Travis
BCDC
30 Van Ness Avenue, #2011
San Francisco, CA 94102

Victor Weisser
Calif. Council for Env. & Eco. Bal.
100 Spear Street, #805
San Francisco, CA 94105

David Roe
Environmental Defense Fund
5655 College Avenue, #304
Oakland, CA 94618

Steve DeYoung
Bechtel
50 Beale Street 45/26/A11
San Francisco, CA 94105-1895

Calif. Dept. of Fish and Game
P.O. Box 47
Yountville, CA 94599

Diane Takvorian
Environmental Health Coalition
1717 Kettner Boulevard, Suite 100
San Diego, CA 92101-2532

Mary Raftery
CALPIRG Legislative Advocate
926 J Street, Suite 713
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